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SCIENCE TO RE-BUILD

MANY scientists have naturally been moved by the horrors of the war to re-examine the scope and content of their moral responsibility as men of science towards humanity. Evidence of this humane anxiety on their part is to be seen in the proceedings of the British Association which held a conference of distinguished scientists of many nationalities in London in September last.

Indeed, no scientist that has not been altogether dehumanized by scarabeeism can help admitting that the modern war (as distinguished from wars of antiquity) is a by-product—an altogether unintended one, it is true; but a by-product nevertheless—of his own workshops. Science has abolished the serene isolation of countries, complicated and queered their economic organization, kindled in them new greeds and new rivalries, and furnished deadlier weapons than were ever available before to their hands. This list of the doings of science is of course only one of the many lists possible; and the other lists are, everyone would thankfully acknowledge, as greatly gratifying as this one is grim. But can there be no helping of these dark spots? Cannot science do something to repair the damage done to life and civilization by the cupidities which its triumphs have brought into play? To think of the various social problems raised or enlarged by science and consider how she could be of service in re-building the world of man now being shattered by forces which her own progress has released, is a responsibility implicit in the influence that belongs to the scientist.

Science may claim that in herself she is non-moral and that she is not to be held responsible for the purposes for which her handiwork has been used or abused by statesman or soldier or manufacturer. To take this stand is, however, not to exalt science, but to lower her status and diminish her significance. To say that a thing is non-moral is not different from denying to it the endowment of anything like soul or conscience. Will science take it as a compliment to be counted a thing blind and heedless and mechanical? Is science to be pursued as an end in itself, or is it to subserve some other purpose connected with our life? In itself innocent, it produces things potent for mischief. Our cook is indeed a most innocent person; but the flavours he sets afloat from the kitchen will not melt away before stirring up the gastric juices of persons equally innocent moving about in the garden. There can be no transaction or occurrence within the field of man's experience,—not so much as the casual glimpse of a face or the chance hearing of a cry,—which can hope to escape registration in the ledger-book of life; and no entry can be there without its credit or debit value in terms of the psychological and character-affecting consequences of the act or the experience. Nothing, strictly viewed, is non-moral,—not even science. The scientist claims that his supreme interest is in truth. Why truth? Of what significance is it? Is it nothing more than curiosity, idle and devoid of meaning and purpose?

The scientist cannot hope to ward off blame by designating himself a simple catalyzer. If that similitude must be kept on, he is, unlike a merely chemical substance, a conscious catalyzer. He surely knows whether what he is helping to produce is medicine or munition, food or poison; and the responsibility with which the world charges him is in relation to his capacity as a human being. Must science dehumanize man? May the scientist remain unconcerned seeing the monstrous misuse of the products of his skill?

The remedy is not to exile science, but to invite more of it. Great as her conquests have been, science has yet to conquer more before her victory could be taken as completed; and these further conquests are to be achieved by her in intimate collaboration with an alert and generous humanism. The misfortune of mankind to-day is that the extent of control over external nature which science has been able to secure for man has not been equalled by the extent of control which he has been able to acquire over his own nature. Hence all the prostitution of the resources of science. Novel, adventurous, utilitarian, marketable, science has gone forward from success to success, not pausing to heed the gentle and steadying voice of the humanistic tradition in our civilization. She has preferred to see man go about hopping on one foot. Science's disregard of the older philosophy is perhaps her only unscientific act.

The universe, it is at least arguable, is a compound of the physical and the transphysical or transcendental. But science's early successes were in the region of the physical. She penetrated far into what had previously been regarded as the mystery zone of nature and extended the frontiers of the measurable and the explainable. In the first flush of these triumphs, it looked as though there could be really no limit to

what the marching intelligence of man can unveil and capture and subdue. It followed from this that what the microscope could not reveal could not possibly exist and therefore did not exist; that reality is reality only if it could be measured by the sicentist's inch-stick. No other tests were to be trusted. The whole host of witnesses from the realms of religion and literature and art were simply out of court. Thus came about the exaltation of the physical and the materialistic and the obscuration of the transphysical and the spiritual. This was just a counter-part of the error that some of the post-Vedic faiths of India fell into, namely—the be-littlement of the mundane and the exaggeration of the supra-mundane. The scales of relative value of both schools must, by the same method of reasoning that true science works by, be set down as erroneous. Our ills of to-day are the off-spring of that imperfect correlation, so to say, between the two quantities of life—a *A* and an *N*—one accessible to our analysing and proving and the other only to be "sensed" subjectively, at moments of intense inward experience and unavailable to objective proving.

The services of science to mankind may roughly be classified under three heads:—

(i) *Intellectual.*—Promotion of the spirit of inquiry and reasoning as against the habit of accepting opinion on trust and out of uncritical reverence for established authority; and assertion of the importance of free human striving.

(ii) *Life-supporting.*—The countless varieties of industrial inventions including all distance-abolishing, time-saving, labour-saving and cost-saving devices, feats of engineering, agricultural recipes, medical and surgical appliances, mechanical gadgets for comfort and convenience; indeed all the immeasurable commercial output of science and technology excepting armaments.

(iii) *Destructive.*—Military material of all kinds.

What has human nature made of these?

(i) *Unfaith.*—The habit of demanding objective proof has made men forgetful of the possibility of there being in existence a something which, while operating in their lives as truly and as effectively as anything visible and tangible, is not to be captured and treated by the apparatus and methods which have achieved such impressive successes in the physical world. So has grown a general scepticism in regard to things of the spirit and an insensibility to values other than those of utility and comfort in the world known to men. What man is able to explain is the true and what he can enjoy is the good. His intelligence and his sensation are to be the sole measurers of reality and right.

(ii) *Acquisitiveness.*—The industrial achievements of science have converted the whole of the varied world into a single market-place, and naked mercantilism has become its working faith. With the multiplication of inventions and concoctions multiply our tastes and cravings; and the din and bustle of the market-

fair continues to grow. What matters is profit and possession, no matter how to be acquired and at whose cost. A ruthless individualism is the rule for men and countries.

(*iii*) *Aggressiveness.*—"Power corrupts" said the great historian Acton. So does the consciousness of power born of the possession of well-equipped armies. Goaded on one side by the urgencies of a standard of living kept continually rising by the progress of science and technology, and tempted on the other side by the accumulating strength of new and more new weapons of war, how could nations restrain the impulse to fly at one another? Power is to be dreaded because of the temptation inherent in it. It always keeps crying to be used; and only those who have for long trained themselves in patience and self-restraint can withstand the temptation. But where is the impulsion for restraint to-day?

So has grown our world-welter. Wars there were in the ancient world; but they were born of the dynastic feuds and personal vanities of kings, not of the land-hunger and oil-thirst of whole peoples. The wars of old limited their operations to the chosen battle-fields and did not upset the economic life of whole communities or ruin the peace of the civil populations in town and village. There was some law of humanity and of honour controlling the soldier of the by-gone age; his successor of to-day knows no such inhibitions. The difference in causation and in method between old-world wars and ours is the contribution—surely the undesigned contribution—of science to human affairs. Scepticism as to the reality of a principle beyond the analysable and the measurable world, mercantilism as the chief inspiration in human relations, and militarism as the sanction of claims of one against another—is it for these that science planned and worked?

Science has put idealism to flight. Mastery of the definite has eclipsed the sense of the undefined. We have left to ourselves no point of reference outside the reach of our own arm for the judging of the true and the good. Is this attitude of self-sufficiency in man scientific? Is it unscientific to postulate the existence of an entity outside Man's own self and Nature to be reckoned with—a Third Partner in the business of life, so to say?

If the old faith in the omnipotence of fate was a superstition, the new faith in the omnicompetence of human intelligence is no less so. If the old surrender to the doctrine of pre-destination was a superstition, the new confidence in the illimitability of man's conquests is no less so. And science which demolished the old superstitions should be as eager to detect and destroy the new ones. The first need of to-day is the correction of the fundamental attitude of the civilised man towards life and its concerns. The need is for that salutary spirit of humility which must come from the recognition of the possibility of a hypothesis of an immeasurable reality—a reality to be "glimpsed"—and perhaps not more than glimpsed—by what one might call the Sixth Sense,—the sense irrelevant to

objects of the physical world, the sense of what truth-seekers of another order have called the soul or the spirit. Having demonstrated the amplitude of man's latent powers, science has now got to make it clear that she has found nothing to warrant a denial of the existence, outside the realm of the physical, of a something which is ceaselessly at work,—through Nature and possibly through the instrumentality of Man himself,—to modify the operations of his power. The second half of the task of science remains to be taken in hand, and it is to help faith to find a place for herself in the life of the civilized man,—faith in the functioning of a Third Partner.

In this article, the word science has so far been used to denote exclusively the natural or physical or "exact" sciences. It is these sciences that have ruled our civilization for some decades now,—roughly since the invention of the steam engine and the railway more than a century ago. To complete the work they have accomplished on the intellectual and moral planes, they have need of the collaboration of sciences less exact—those called "social sciences"—and of non-sciences, too, which are no less valid registerings of the experiences of the human spirit in its quest after the true and the good,—those intimations of the deeper springs of life which come to us through poetry and music and the variegated story of the struggles of men and nations for improving themselves called history. Life, in all conscience, is the most serious business that man has to think of, and the veriest maximum of wisdom that he can possibly garner may not prove adequate for its purposes. But if that wisdom should be not less even by an iota than the maximum that our effort can make possible, we have need to attempt a correlation and synthesis of the fractions of knowledge and thought available from every conceivable department of the activity of man's intellect. Our attitude should be scientific; and the truly scientific attitude cannot deny recognition even to realms of being where one works by faith and faith alone. It is rational to argue that, in such realms of faith, there is always the possibility of illusion and hallucination and self-deception. Against these errors, we have some protection in the critical and checking apparatus furnished by one body of knowledge towards another. It is possible that even after all possible eliminations of error and illusion have been made by criticism, a residuum of error and illusion will remain. But that is a risk against which we are helpless and to which therefore we must prepare ourselves to be reconciled. In other words, a scientific consideration of the duty of man towards himself seems to suggest that he should learn not only to strive through a rational synthesis of knowledge to improve his condition, but also to bear manfully such failures or frustrations as all his reason and skill may not be able to avert. He needs a certain quality of resignation as much as he needs the will to constant effort. Paradoxical as it may seem, striving and resignation are both equally parts of wisdom.

Nature has implanted a paradox in the heart of man; and all conflicts in the world are its logical issue. He is both social and anti-social,—both self-centred and self-denying,—one moment obsessed with himself, another gazing at the stars and glad to

be absorbed into starlight. What science has done to him is to stimulate the egoistic in him to the neglect of the altruistic. It has tilted the balance of the soul. Restoration of the equilibrium is now the first need.

Many minds naturally have been at pains to make plans for the reconstruction of the world. These attempts have generally been in the direction of schemes for the combining of States into federations or unions. Some are suggesting an imperial federation under the hegemony of Britain, some a federation of the world under a Super-State charged with the office of securing peace and security to all nations under the sun. Various are the plans, and each has its own special recommendation. But the first stage of the approach to the problem should be through ethics and economics and not through politics. The police and the magistracy should follow, and not precede, legislation; and the legislation needed is in respect of the distribution of the goods that the world has to offer. Measuring the goods and creating the machinery for their distribution is the task of economics; and enunciating the principles of distribution is the task of ethics. Sir P. C. Ray, the doyen of Indian scientists, has spoken not only as the authentic voice of India, but also as a votary of equity and justice in world's affairs, in saying, in his letter to Sir Richard Gregory, President of the British Association, that "the question of scientific reconstruction of society on principles of freedom and justice for all should not have geographical limitations" and that "the problem of the freedom, progress and happiness of mankind is indivisible in the modern world".

A correct diagnosis is half the cure, and the first half. Sir P. C. Ray has laid the finger on the central plague-spot of the existing politico-economic structure of our civilization. The implications of his remonstrance are two: (*i*) Humans should all be treated as Humans,—not as Whites or Browns or Blacks; and (*ii*) as a corollary to this, conditions of good living should be secured to all alike. In the numerous schemes now being put forward for the reconstruction of the world, the people generally taken into account are those of the European or white races, or of States at present sovereign and self-governing. In a discussion of "equal living-space for all nations,"* for example, attention is confined to "the seventy-two self-governing States of the earth",—India and many other countries not being among them. Similarly Mr. Churchill has made it clear that the Atlantic Charter† (referred to by Sir P. C. Ray) is to apply only to "States and Nations of Europe now under Nazi yoke". As if the rest of mankind do not count! As if they have no grievances! As if their grievances and aspirations would not matter!

It is surely not being scientific to ignore an axiom; and the first axiom pertinent to world-planning is that the prime motive force of life is hunger; that hunger does not know black from brown and brown from white; that hunger unsatisfied is the sure beginning of insurrection. It is idle to contend that the non-white or the non-self-governing peoples of to-day are not within the pale of civilization or are on a lower

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* R. R. Kuczynski (Oxford Pamphlet 8).

† The joint declaration of War Aims by the British Premier Winston Churchill and the American U. S. President F. D. Roosevelt on the 14th of August 1941.

level of it. If what is termed civilization is worth anything, they are all candidates for it. The example of the white and the self-governing is enough to convert the rest from potential into actual contestants for the world's goods. Unless the white and the self-governing are prepared to extirpate the coloured and the subjugated, they must be prepared for a conflict (as Sir P. S. Sivaswamy Aiyer pointed out the other day in a Madras speech)‡ between the "satisfied" and the "unsatisfied" of the earth, between the "haves" and the "have-nots". What then is the present planning to be for? For dispossessing a portion of the race? Then it can not possess even the merit of durability: No unscientific arrangement can stay long.

Conditions of good living are not easy to define; but they are understood easily enough even without a precise definition. The Atlantic Charter has compactly described them as "a *peace* which will afford to all nations the *means of dwelling in safety* within their own boundaries and which will afford assurance that all men in all lands may live out their lives in *freedom from fear and want*." (Of course the word "all" in the quotation is to be taken as qualified by "white", "self-governing" and "European".) A little more in detail, the conditions are a sufficiency for all of living-space and of raw materials convertible, through money, into food and clothing and shelter and other necessaries of life; free markets; facilities for education and work and recreation; leisure to attend to the deeper longings of the mind and the spirit; sense of freedom; sense of individual worth and usefulness as a unit of the human race. Who is there that does not ask for these? Those who have no appetite for any of them to-day are not to be counted upon as likely to remain sluggish for all time. Good example will tell, even upon the Asiatic and the African; and if the European and the American do not want to have trouble to-morrow, they had better realize to-day once for all that the safest course for them is the course of righteousness—treating all humans alike. Equality—the heart-string of humanism and the vital sap of democracy—is not only a principle of justice, but also one of expediency in view of the certainty of the later uprising of those who are now left ignored because of their powerlessness to make themselves heard. If planning is not to be based upon this principle, the name proper to that proceeding would be a less innocent word. A preliminary question, then, to be answered by those who will have it in their power to give effect to any plan is this—whether they are prepared to regard all human beings as human beings and as entitled to look for equal treatment to the extent practicable in the future world-organization and whether they would observe equity in the distribution of what our common mother earth has to offer her children?

The need to set up an agreed international agency, to carry out an agreed programme of measures for world peace is self-evident. What are to be the items of the programme? Many lists have been drawn up—the so-called Atlantic Charter (cited below as A.C.) being one. And here is one offered from a somewhat different point of view:—

(1) *Living-space for all.*—This includes not only the surface area of the globe,

‡ The "*Hindu*", November 17, 1941.

but also the underground resources. The A.C. has recognized the principle that all territorial settlements should be in accordance with "the freely expressed wishes of the peoples concerned". America, by an Inter-American Conference (1936) declaration, has accepted the principle that all territorial conquests should be proscribed and that "no territorial changes resulting from the use of violence are to be recognised by any government". The question is one too complicated to be solved without reference to the local history and conditions of each area. An expert body of economists, demographers and other specialists will have to furnish the necessary advice. But the general principle is that each State or political community should have enough command of the earth's space to be able to find sufficient food and occupation for all its present population and also any increase forecast as likely on the basis of census statistics. An iniquitous distribution of the first gift of nature is the root-cause of all disturbances to the peace of the world; and no settlement can last which has left a sense of unfairness in the mind of any community or nation.

(2) *Democracy Everywhere.*—The A.C. promises to "respect the right of all peoples to choose the form of government under which they will live". But this is not necessarily upholding the cause of democracy. People in the Totalitarian States of to-day are not free really to exercise their choice. It is also not unlikely that there may be a large section of the public in a country habituated to taking short-range views in preference to long-range views under the stress of war conditions; and to such people a dictatorship may appear a surer means of ensuring efficient government. Is it not the boast of the bureaucracy that its administration is more "efficient" than a democracy's can ever be? Dictatorship, oligarchy, bureaucracy, indeed any form of government by a body which is not open to the scrutiny and control of the citizen-body may be right in claiming to be more capable of efficiency than a democracy; but it is a potential exploitation-field for capitalists and armament-makers and manufacturers and money-grubbers of all kinds, and thus a breeding ground for war-microbes. It is the public at large that suffers the worst when a war is on; and therefore it is the general public that is the most interested in preventing bellicosity. The slogan during the last war was about "making the world safe for democracy". But our experience since then has shown that it is democracy that can make the world safe for humanity. To make this claim for democracy is not to count it infallible. It has weak spots like all other human institutions; and the ways of strengthening it are a big enough subject to merit a separate study. But no democracy can feel confidence about its own safety so long as there is left an autocratic or oligarchic or totalitarian or otherwise "irresponsible" government anywhere in the world; for these are the potential breeders of aggression and imperialism. No household can go to sleep in a sense of safety when there is a plague-infected street in the neighbourhood, or the presence of burglars is suspected about the town. To establish democracy everywhere is the only true way of making the world safe for democracy. But it must be admitted that many parts of the world are at the moment not fully in a condition to adopt a democratic regime; and they need time, and perhaps assistance, to prepare themselves for it. When, however, it is once definitely decided that democracy—with State socialism in some form as its programme—is to be the political ideal for all, the question of arranging help to the less prepared will be merely a matter of devising machinery. There is a precedent, but certainly no example, in the Mandates system of the League of Nations. Speaking from the standpoint of ideal perfection, one must admit that no country in the world has yet been able to reach the peak in the democratic enterprise, and that even the most advanced has still a long distance to cover. That being so, it is for no one now to question another's fitness. There is no question of racial or geographical or linguistic or other peculiarity

intrinsic to democracy; and its essential principle is one of universal human nature. All members of the human family are educable to it; and those advanced should, to be consistent with their own ideal, look upon the education of others for democracy as "a sacred trust of civilization".

(3) *Limitation of Aramaments*.—The A.C. approves of the ideal of "the abandonment of the use of force" and promises support to all "practicable measures which will lighten for peace-loving peoples the crushing burden of armament". The covenant of the League also (Art. 8) contemplated the reduction of armaments. But the League was singularly ineffective there. The control to be exercised should be not merely in respect of munitions factories, but also in respect of their laboratories. There is a very special responsibility for men of science here. They must willingly submit their researches likely to be useful for military purposes to be examined, and their reports of results to be controlled, by an international agency. When knowledge of a new death-dealing invention is made accessible to all countries alike, their rivalries in military equipment will in effect have been reduced by half.

(4) *Economic Development for All*.—Each State should be helped to ensure to all its subjects a minimal standard of earning and welfare; for, a full-fed stomach is the surest guarantor of peace. It is of course difficult to fix the datum line. Economists must help us here. It is perhaps inevitable that the contents of the minimum must vary from country to country; also that the minimum should keep rising to a higher point from year to year. The appetite grows with what it feeds upon; and the State which is indifferent or inefficient in satisfying it is a source of danger not only to itself, but also to the international body politic. In this task, therefore, a State would be entitled to look for international co-operation and help. The help should take these forms:—

(i) An international bank or financing institution to lend money for development purposes, such loans involving no political or military or trading obligations towards any one country or State;

(ii) Supply of technical knowledge and skill and industrial machinery;

(iii) Open markets: The A.C. is grand on this point. It would "further the enjoyment by all States, great or small, victor or vanquished, of access on equal terms to trade and to the raw materials of the world which are needed for their economic prosperity". This must involve a revision of the system of tariffs, and economists should be our advisers.

It should be made both possible and obligatory for each and every State to so manage and use its resources that, while individual initiative and enterprise are encouraged, there will be no monopolistic clot in the economic life of the community and so that there will be an equitable distribution of the means of welfare throughout all classes of the population.

The doctrine of economic self-sufficiency as the goal for a country has been blamed as the inspirer of bellicose designs. That doctrine, when it assumes an extreme form, is undoubtedly unsound economics. A country's economic boundaries cannot always coincide with its geographical boundaries. Its needs are larger than its resources. Its attempts at self-sufficiency must therefore sometimes involve both waste of its own material and disturbance to some other country's prosperity. But what about economic aggrandizement which would keep other countries primitive and undeveloped so that they may remain available for exploitation as producers of raw-material and markets for finished goods? In truth, the less developed country is the bone that provokes contention among the better developed.

The A.C. is indeed gratifyingly adequate on the question of international co-operation

towards economic and social improvements. It desires "to bring about the fullest collaboration between *all* nations in the economic field, with the object of securing *for all* improved labour standards, economic advancement and social security".

A reconstructed League of Nations—reconstructed radically so that it could find more strength in its arms and more courage in its heart,—seems to be the agency for executing a programme like the one just sketched. Experience has shown us the deficiencies in its present structure and sanctions. The League should be made to include every country of the world in its membership and should be enabled to organize effective action against the recalcitrant. Developing the existing organization seems clearly a more advantageous course than trying to set up a Federal World State made up of the funded part-sovereignties of component States. The idea of such a Super-State is new and not easy to the international public; and they would naturally require time to grow familiar with it and appreciate its appeal. The way to it may be through a more vigorous working of the League. The League, faithfully supported, may itself evolve into a federal world-government in course of time.

But let us be warned never to expect to find an earthly paradise about ourselves. With the best League or the strongest World-State,—the British leading it or the Americans helping it or the whole host of the saints and sages of history inspiring and guiding it,—with all its most earnest care and its most devoted exertion,—man may still find some things not according to plan, some forces not yet amenable to reason. To be prepared for such contrarious contingencies should be part of his self-discipline.

Arnold Toynbee, one of the truest of friends the common man ever had anywhere and one gifted with a sage's insight into the problems of our age, wrote these words which, after sixty years, have lost none of their appositeness:—

> "Men's rights will clash, and the reconciliation must come through a higher gospel than the gospel of rights,—the gospel of duty; that gospel which MAZZINI lived to proclaim; for not Adam Smith, not Carlyle, great as he was, but MAZZINI is the true teacher of our age ... MAZZINI was a democrat who spent his life in struggling to free his country; but he believed in liberty not as an end but as a means—a means to a purer and nobler life for the whole people. The time has come to preach this gospel."

With our best effort and best propitiation, the Third Partner,—he who puts in the element of uncertainty into our calculations,—may choose to go his own way and not ours; and then our refuge must be in a sane philosophy of cheerful fortitude and renewed endeavour.

> "To live, and bear; to hope till hope creates
> From its own wreck the thing it contemplates;
> Neither to change, nor falter, nor repent."

Conditions of peace are only partly in man's environment; partly they are within himself. If the world must give him a little, he must also be prepared to go without a little. An arduous and persistent fight for rights has given the modern man a fretful habit of mind; it has put the soul in an attitude of perpetual rebellion. That is as grave a menace to the world's peace as the external injustices he complains of. After

all, a certain degree of forbearance and resilience are indispensable if we should keep a proper sense of values and remain friends with our fellow-men. The promoting of such mental equipose and will to peace is no small part of the work for a better world-order. And that is the mission of great literature and great art. The League of Nations was most happily inspired when it set up the Committee for Intellectual Co-operation. An agency like it should,—by means of translations of great books, lecture tours of leaders of thought, local gatherings of public-spirited men and women for study and discussion,—help to bring about a better knowledge between the countries of the world of their respective cultures and civilizations, their attitudes towards life and their habits of thought. Understanding so promoted is bound to prove a strong asset to the cause of peace. Men will not then be so ready to take umbrage and fly to arms. And minds so liberated, having horizons so broadened, may be trusted to throw their weight on the side of sanity and good sense when the jingo is abroad.

The problem of permanent world-peace has for long engaged the minds of philosophers and poets. Kant dreamt of a confederation of States, and Tennyson sang for a warless world—

> When the war-drum throbbed no longer, and
> the battle-flags were furl'd
> In the Parliament of Man, the Federation of
> the World.

But scientists do not seem to be so sanguine. Some of them, at any rate, see an insurmountable obstacle in the very constitution of our hormones. Seeds of prejudice and jealousy are inextricably fixed there, and who can cast them out? The Vedic seers have taken the view that man is a mixture of good and evil, and that the disciplines of social duty and religious devotion as well as intellectual and æsthetic culture should serve to handicap the brute and give advantage to the angel in him. The sober statesman is he who, while being glad to deal with all as if they were angels, would none the less keep himself prepared to meet them even if all turned out brutes. Let us work for world-peace: but let us not behave as though it were already a fact.

In all our attempts to establish a new world-order, we should take care to keep clear of one delusion if we would avoid futility and vexation. It is given to no scientist, and to no statesman or economist or social reformer either, to turn this world of mortal men into anything to compare with the paradise of which poets and prophets of religion have spoken. The ideal portrayed by the poet and the prophet is of use but as a pointer and an incentive to effort; the disciplines which its acceptance must impose on us would be of value; the strength resulting from such disciplines is bound to be valuable: approximations towards the ideal as a result of this growth of strength must also follow in the train. Ideal therefore there must be, and effort in its direction; but with that effort the courage to face a failure and the faith for renewed effort. Man's practical wisdom can never prove sufficient for the visions of felicity granted to him. No poet's verbal ingenuity was ever equal to the nuances of his imagination; no painter's brush ever fine enough for the shades of the picture his mind has visualized. There is always an inevitable hiatus between the ideal in the mind and the accomplishment of the hand.

Such is the intractability of the material upon which the statesman (like the artist) has to work. Man's progress therefore cannot be an uninterrupted and continuous and unlimited increase of strength and felicity. It is rather the securing of the recurrence of flood-tides. Have we a sufficiency of vital energy in ourselves to feel sure of its rise after a fall of the wave? Is there sap enough in the root for the plant to survive from autumn to spring? Evaporation of water being unavoidable, is there a goodly stock in our reservoir to outlast the summer? We are then on the road of progress. So it is in a modest and chastened attitude that we should take up the task of re-building our civilization.

D. V. G.

HAFFKINE INSTITUTE

THE Annual Report of the Institute for the year 1939, records an impressive advance in all directions, particularly in the field of research. It is a matter of supreme gratification and an example worthy of emulation, that the Institute, which is burdened with the principal routine of providing large quantities of plague prophylactic and other vaccines and of carrying out diagnostic work for hospitals and private practitioners, should take upon itself the responsibility of organising a research section and achieve results of great value. These activities were generously supported by a grant of Rs. 50,000 from the Indian Research Fund Association and by the endowment of two research scholarships by the Lady Tata Memorial Trust.

Special attention should be invited to the syntheses of a series of new sulphonamide compounds undertaken by Mr. K. Ganapathi, one of the Lady Tata Scholars, in connection with chemotherapy of plague. The Director remarks, "Researches into the chemotherapy of plague have yielded very important results and beget the hope that an effective remedy for bubonic plague is within sight."

Reporting on the clinical results of these drugs, Col. Sokhey writes, "In spite of the inadequate dosage, the curative results are remarkable. Further, these sulphonamide drugs have many advantages over the serum. The drugs are administered by the mouth, are comparatively cheap to make and do not deteriorate on storage. While anti-plague serum is expensive to produce, has to be administered by the intravenous route and deteriorates very rapidly unless stored in refrigerated space. In India where plague is now almost entirely a rural problem, the sulphonamide drugs have everything in their favour. Further, and this is more important, the same drugs are equally effective in a number of other infections, such as pneumonia and blood poisoning."

Col. Sokhey continues "Synthetic organic chemistry has, during recent years, yielded compounds of the greatest value to medicine. It is certain that this particular branch of research is destined to become even more important in the near future, particularly the chemotherapy of bacterial diseases. There is a great deal of chemical talent available in India, but chemists working in isolation by themselves cannot achieve much. For worthwhile work intimate collaboration of chemists, bacteriologists and pharmacologists is essential. The Haffkine Institute is admirably suited as centre for such collaboration. It would be a great gain if a permanent department of chemotherapy is organised at the Institute." We fervently hope that Col. Sokhey's idea of a permanent department of chemotherapy will soon be realised.

X-RAYS, CRYSTALS AND THE INFRA-RED SPECTRUM

BY

SIR C. V. RAMAN

THE *Proceedings of the Indian Academy of Sciences* for October 1941 is devoted to a symposium of fifteen papers dealing with the interaction between X-rays and crystals which results in an excitation of the infra-red vibrations in the solid and a consequent reflection of the X-rays with change of frequency. This phenomenon was first described in an article in *Current Science* for April 1940 by the present writer and Dr. P. Nilakantan, and was further reported on in the issue of *Current Science* for May 1941. The symposium now published is a comprehensive account of the whole subject and shows that the new facts and ideas put forward in April 1940 were solidly based on reality. The theory given in broad outline in earlier publications is now fully developed and finds striking experimental confirmation in various directions.

The phenomena of the scattering of light in crystals show clearly that the interactions between matter and radiation which involve a change of frequency in the latter can only be successfully interpreted on the basis of quantum mechanics. That a similar situation also arises in regard to X-rays becomes evident when it is recalled that the secondary X-radiation from a vibrating atom in a crystal appears, in part, with a change of frequency. Any coherent vibration of the atoms in a crystal with a specifiable frequency is therefore capable of giving rise to radiations of altered frequency which can interfere with each other and give rise to observable effects. The change of frequency involves an exchange of energy between the crystal and the electromagnetic field, and this can only occur in complete quanta or units of the particular vibration frequency. The interferences which arise may therefore be regarded as due to an inelastic collision of the X-ray photons with the crystal lattice. They appear as geometric reflections of the X-rays by the lattice planes of the crystal, analogous to, but quite distinct from, the reflections of the usual kind involving no change of frequency.

The vibrations possible in a crystal lattice may be classified under two heads. The first kind are of the macroscopic or elastic type which may be described without specific reference to the atomic architecture of the solid. They present a continuous spectrum of frequencies, and when the limiting wave-length is chosen sufficiently large, their aggregate energy is small, while the energy of a particular frequency of vibration is quite negligible. In these circumstances and in view of the arbitrary wave-length and orientation of the elastic vibrations, their effect on the X-ray propagation is very small, appearing as a diffuse scattering. Of much greater importance from the X-ray point of view are the atomic or infra-red vibrations which involve a time-periodic variation of the fine structure of the solid. These have higher frequencies than the elastic vibrations and appear as monochromatic lines in the infra-red spectrum of the solid. The nature of these vibrations is very fully discussed in the opening paper of the symposium. It is shown that the observed monochromatism of the infra-red vibrations indicates that they take place in a completely ordered fashion, the frequency, amplitude and phase of the vibrations being identical over extended domains in the crystal. The result of such synchronism is that the associated secondary X-radiations have coherent phase-relationships and give rise to X-ray reflections of observable intensity in geometrically specifiable directions. (See Fig. 1.)

The second paper of the symposium is devoted to a mathematical formulation of the theory. The classical and quantum reflections are considered together, as it appears from the theory that they stand in close relation with each other. The secondary radiations from the vibrating atoms in a crystal are analysed, and expressions are derived from the static and dynamic structure factors. In the limiting case when the lattice vibrations are in perfect synchronism in all the cells of the crystal, the intensity problem admits of a complete solution, as the vibration energy of each lattice cell may be then taken as one quantum of the particular frequency. The calculation shows that the quantum X-ray reflections have

an appreciable intensity, smaller than but not negligibly small in comparison with, the intensity of the classical reflections.

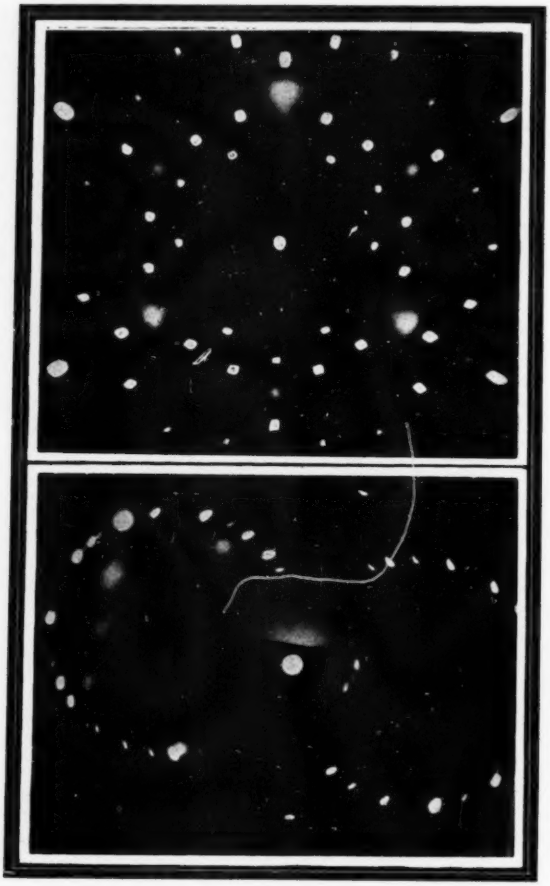

Fig. 1

Quantum X-ray Reflections in Benzil Crystals

The third paper in the symposium presents the experimental evidence in a particular case, *viz.*, that of diamond, quantitatively confirming the theory. Particularly noteworthy are the photographs of the (111) quantum reflections of diamond taken with a very fine beam of X-rays and very prolonged exposures and reproduced as Fig. 6 in Plate XVIII accompanying the paper. The reflections appear as exceedingly fine lines in the record, indeed as sharp as they would be if they were true geometric or specular reflections without any angular spread. These two photographs alone would be sufficient to show that the various alternative theories of the phenomenon which have been recently put forward in the X-ray literature are untenable. All these theories indicate a broad or diffuse scattering, instead of a sharply defined geometric reflection as is actually observed in the case of diamond.

Of the remaining twelve papers in the symposium, no fewer than six are contributed by Dr. C. S. Venkateswaran. Particularly valuable are his studies of the intensity of the quantum X-ray reflections at liquid air temperatures by a series of crystals, *viz.*, carborundum, rock-salt, sodium nitrate and penta-erythritol. The experimental data are in complete accord with the theoretical formulæ and indicate that such X-ray studies with crystals open a new avenue of approach to infra-red spectroscopy. The case of metals dealt with by Mr. Bisheswar Dayal in another paper in the symposium is an instance where such an approach might prove of great importance.

An important result indicated by the quantum theory of X-ray reflection is that in particular cases, the classical reflections may vanish while the quantum reflections persist, or *vice versa*. In a remarkable paper appearing in the symposium, Mr. Rama Pisharoty calculates the intensities of the (222) and (662) quantum reflections by diamond and shows that they are in agreement with the intensities as actually observed, thereby indicating that these so-called "forbidden" reflections which should not appear on the classical theory are in reality quantum reflections. Another remarkable case of the kind is furnished by the ratio of the intensities of the (111) and (222) reflections by the lattice planes in rock-salt. The theoretical calculations by Dr. Venkateswaran indicate, in striking agreement with observation, that this ratio is far smaller for the quantum reflections than for the classical reflections.

Four of the papers in the symposium deal with the case of organic crystals, *e.g.*, naphthalene, benzophenone, hexamethylene-tetramine and benzil, Fig. 1 above is

reproduced from the plate accompanying Mr. R. V. Subramanyam's paper on benzil. In the case of aromatic compounds, the infra-red vibrations with which we are principally concerned are those of relatively low frequency involving rotational or translational movements of the aromatic rings. It is evident that the crystal planes parallel to the aromatic rings would be strongly affected by such movements and would therefore give intense quantum reflections, while the lattice planes parallel to the rings would be unaffected by such movements and would therefore fail to give the quantum reflections. This indication of theory is strikingly confirmed by observation. Indeed in the case of benzil, the intense quantum reflections observed immediately indicate the number, orientation and azimuth of the benzil molecules present in each lattice cell.

CAMOUFLAGE PAINTS

BY

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SINCE the World War of 1914–18 the word camouflage, originally a French word, has been adopted throughout the world to denote a particular type of military deception in which paints and artists play the major role. In the unrestricted sense the word may be applied to any device which is calculated to mislead the enemy. Such general camouflage has been practised by belligerent nations throughout history. The Wooden Horse of Troy, the Moving Forest in Shakespeare's Macbeth and the incalculable Shivaji's escape in a basket of sweetmeat under the very nose of Aurangzeb are some of the popular examples of camouflage in the general sense. Napoleon is known to have made extensive use of camouflage in his campaigns, and it will be readily understood that in war, in which everything is considered to be fair, military deception must occur to generals and soldiers alike as almost a first principle.

As in all great things, man learnt the broad principles of this art of military camouflage from nature. She is the effortless master camoufleur who resorts to camouflage in order to preserve her species. Examples of nature's camouflage extend from the tropical vegetation, through the desert sand, to the bare winter twigs of the temperate zone and the snows of the Polar regions, and these are too many and well known to mention. The principle followed by nature is to produce species which in colour and form are more or less indistinguishable from their surroundings in order to avoid easy detection by enemies. Much of the military camouflage follows exactly the same principle. Gun positions, machine gun emplacements, observation posts, aerodromes, industrial buildings and large installations have to elude detection by the searching eye of the enemy from the air, and the means is camouflage which renders them indistinguishable from the general surroundings. Ships have to mislead submarine commanders as to their exact course, and "dazzle painting"—a form of camouflage in paints—was one of the devices adopted during the last Great War. Even the colours of the field uniforms are a form of camouflage.

Camouflage as an established military and naval practice originated during the Great War of 1914–18. The French gave the lead and the British and the other belligerent nations followed and developed the principle and practice rapidly in all possible spheres. As the aerial eye became ubiquitous and the aerial attack the most potent form of warfare, the necessity for reasonably effective camouflage became one of the fundamental concerns of Governments and fighting forces.

In this article it is proposed to deal with the technical aspects of camouflage paints which are being used in colossal quantities in all belligerent countries. Extensive demands have arisen in this country and paint manufacturers in India are being required to supply large quantities at short notice. These demands are likely to increase as the war situation develops in the Middle and

Far East. Although the special characteristics of camouflage paints were generally known, the paint manufacturers in India were not actually concerned in their manufacture until the war demands arose.

Whereas camouflage painting started as an art, both paints and schemes of painting are now based on definite scientific principles. The effective application of these scientific principles in devising schemes of painting requires the services of biologists, psychologists, artists and service men who have made a special study of the subject of camouflage. Schemes considered satisfactory during 1914–18 have in many instances been shown to be ineffective under the conditions of the present war, and last year *Nature* published strong criticisms of many of the camouflage efforts in England and attributed the unsatisfactory state of affairs to Government's failure to utilise the services of trained biologists and psychologists. Indeed, the camouflage problems under the present conditions of warfare have become highly complicated, and reasonable success can only be expected if the services of biologists and psychologists as well as of artists and service men are harnessed to the work. It is obvious that an intimate knowledge of natural and physical sciences alone can result in forming perfect camouflage effect. By the aid of infra-red photography it is possible to distinguish between opaque mineral colours and organic pigments transparent to these radiations. A reconnoitring aeroplane with a photographer provided with infra-red ray photographic equipment can thus easily detect camouflage in mineral colours against the natural backgrounds of trees, foliage, flowers, etc. It is possible to devise ways and means which will obviate this drawback, but the financial aspect has to be taken into account.

The colours of camouflage paints have been standardised, and as used in the British Empire, these now number seventeen. The colours are all dull and range from different shades of dull brown and red, through dull greys and greens, to black.

One of the most important characteristics of camouflage paints is that they shall dry to a perfectly matt surface. Even a trace of gloss on a painted surface will cause sufficient reflection of light to make objects look prominent from the air. At no angle of observation must there be the slightest suggestion of reflection, and this property must be maintained when the surface becomes wet by rain or dew. The question of fastness of colour is also a very important one, since premature fading may so alter the colour scheme as to render camouflage completely ineffective. This consideration imposes a definite restriction as to the range of pigments that can be used in the camouflage paints. Camouflage is not concerned with the protection of structures from the effects of atmospheric conditions and in that sense durability of the paint is not of importance. On the other hand, from the camouflage point of view a reasonable degree of durability is necessary, and this point has to be borne in mind particularly because the average matt paint shows poor durability when used for outside work. The formulation should, therefore, aim at combining perfect mattness with adequate durability.

In the evolution of camouflage paints many different possibilities, such as flat oil paints, oil-bound distempers, bitumen emulsion paints, wax paints, lanoline emulsion paints, silicate paints and cement paints, were investigated. Of these, three types that have been accepted as standards are flat oil paints, oil-bound distempers and bitumen emulsion paints. In India developments so far have been in the direction of flat oil paints, but the possibilities of bitumen emulsion paints are being investigated.

Camouflage paints are made in both gritty and non-gritty forms. The former is specially suitable for roofs and dries with an uneven surface which counteracts any tendency on the part of rain or dew deposition to reflect light. It is obtained by adding a suitable proportion of a coarse extender to the general formulation for the non-gritty paint. The proportions may be 50 lbs. of the coarse extender to 100 lbs. of non-gritty paint with an allowance for additional medium to ensure correct consistency. The gritty material must be non-reflective, and among those considered to be suitable for the purpose may be mentioned silica, slate powder and pumice powder passing through 40 mesh but retained on 80.

Of the possible white base pigments available for the formulation of camouflage paints, lithopone is acknowledged to be the most suitable, although in ordinary paint

practice lithopone is rarely used for exterior work. The other white pigments, such as zinc oxide, white lead, titanium dioxide, etc., show certain disadvantages, but so far as India is concerned, the supremacy of lithopone is substantially compromised by the fact that this pigment is not manufactured in the country and there has for some time been a definite shortage of the material in the Indian paint industry. Zinc oxide, on the other hand, is manufactured in India, and although owing to the limited capacity of the only one existing factory and difficulties of obtaining the metal, the issue of this pigment is being controlled during the war, it is available against Government orders for paints and consequently available for making camouflage paints. It is to be presumed, therefore, that much of the recent efforts at making camouflage paints in this country has been on the basis of zinc oxide, and unless adequate facilities can be given by Government for continued importation of lithopone, zinc oxide may have to be invariably used by paint firms in India in place of lithopone.

The only red pigments permitted in camouflage paints is red oxide of iron—natural or manufactured—and red ochres. The use of organic dyestuffs is prohibited. The yellow pigments are confined to yellow ochres and chemically prepared hydrated oxides of iron. Lead chromes, zinc chromes and organic yellow colours are prohibited. Different shades of natural and synthetic oxides and hydroxides of iron can be mixed in any proportions to obtain the desired effect. Red oxides and yellow ochres are abundantly available in India.

The most suitable green pigments for camouflage paints are chromium oxide and pigment green B, which is an insoluble dyestuff. These are not ordinarily available in India, and paint manufacturers have presumably to resort to mixtures of Prussian blue and yellow ochre or of ultramarine blue and yellow ochre. These mixtures have limitations from the camouflage point of view but are unavoidable under the present conditions.

Raw and burnt umbers can safely be used for tinting purposes. The permissible black pigments include black oxide of iron, mineral black, carbon black and lamp black. The umbers and various black pigments are stocked by paint manufacturers in India.

Apart from whiting and gypsum which are not favoured for camouflage paints, the majority of the usual extenders are considered suitable. Owing to their flatting properties, barytes and silica are largely used in these paints, and possibly the paint manufacturers in India rely mainly on barytes. China clay, French chalk, asbestine and bentonite may be used in small quantities with advantage, as these reduce the setting tendency of pigments. Owing to the fact that a considerable time may elapse between supply and use and in view of the unusual conditions under which these paints may have to be used, it is very important that manufacturers' formulations should provide adequately against the hard settling of pigment. The tendency to settle may also be checked by using heavy-body litho oil in the medium or by using a small amount of a dispersing agent, such as aluminium stearate or aluminium palmitate.

As an illustration of the composition employed, a few representative formulæ employed in trade are given below:

1. LIGHTER COLOURS

Pigment ..	.. 70%
Non-volatile medium	.. 10%
Volatile thinner	.. 20%

Composition of pigment:

Zinc oxide or lithopone	.. 30%
Tinters ..	.. 10%
Extenders and argillaceous matter ..	.. 60%

2. DEEPER COLOURS

Pigment ..	.. 70%
Non-volatile medium	.. 10%
Volatile thinner	.. 20%

Composition of pigment:

Zinc oxide or lithopone	.. 20%
Tinters ..	.. 20%
Extenders and argillaceous matter ..	.. 60%

3. RED OXIDE COLOURS

Pigment ..	.. 75%
Non-volatile medium	.. 10%
Volatile thinner	.. 15%

Composition of pigment:

Red oxide with other tinters if necessary ..	.. 66%
Extenders and argillaceous matter ..	.. 34%

There are many ways open to manufacturers to secure a perfectly matt surface in paints, and the principles involved are well known to them, since the production of matt paints for interior decoration is a common necessity even under ordinary conditions. The same principles are applied with suitable modifications to the manufacture of camouflage paints, but as already mentioned, a certain standard of durability under outdoor conditions, which is not necessary in ordinary matt paints intended for interior use, has to be ensured. A matt surface in a paint is governed by several factors which include the following:

Character and proportion of non-volatile medium.

Proportion of solvent.

Character and proportion of pigment.

A high pigment content is unavoidable in camouflage paints. Some pigments are more useful in producing a matt surface than others. In the case of flat oil paints which represent the camouflage paints made in this country, the non-volatile medium consists of linseed oil and/or certain types of varnishes, and the thinner is usually white spirit.

It has been mentioned earlier that oil-bound distempers can be used for camouflage purposes, although it is doubtful whether any of the paint firms in India has offered this type of material against demands for camouflage paints. Oil-bound distempers are essentially pigmented oil-in-water emulsion with glue or casein, or a mixture of the two added to the composition. The same restrictions regarding the choice of pigments as have been mentioned above apply to oil-bound distempers intended for camouflage purposes. The oily portion generally consists of a suitable linseed oil varnish containing natural or synthetic resin.

Bitumen emulsion paints for camouflage purposes are an extension of the principle underlying the production of bitumen emulsion as a road dressing material. Bitumen and water together with emulsifying and stabilising agents are the sole ingredients of bitumen emulsion. In bitumen emulsion paints, the proportion of bitumen has of necessity to be comparatively small, since the colour of the added pigments should not be materially affected. As these paints are also required in the standard camouflage shades, the formulation of pigments is generally similar to that adopted in the case of flat oil paints. Bitumen emulsion paints are particularly useful for asphalted surfaces, such as roads and bitumen roofing, as oil paints are not practicable on such surfaces owing to the bleeding effect. These paints are also supplied in gritty and non-gritty types. Attempts are being made to develop this type of camouflage paints in India, but it is unlikely that any large supply has actually been made yet.

From the foregoing description of the composition and characteristics of camouflage flat oil paints, it is clear that tests should be of a thorough character and must include the following points:

1. Complete chemical analysis to show the proportions of pigment, non-volatile medium and thinner and the detailed composition of pigment.
2. Physical tests to ascertain the time of drying, and nature of film on steel, concrete, wood, etc. (finish, hardness, opacity, complete freedom from gloss at all angles, etc.).
3. Fadeometer test to ascertain the fastness of colour.
4. Accelerated weathering test to ascertain the durability of paint.
5. Storage test to ascertain the keeping property of paint.

The expenditure involved in camouflage paints is very large indeed, and the effects of using unsuitable paints can be disastrous. It is, therefore, of the utmost importance to both suppliers and consumers that due care is taken in matters of manufacture and test.

A FRESH CYCLE OF THE DESERT LOCUST IN INDIA

BY

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INTRODUCTION

BEFORE describing the events, associated with the initiation of a fresh locust cycle in India in the summer of 1940, a brief account of the history of the previous locust visitations and main features in locust biology should be of interest to the readers of *Current Science*. There are several species of locusts found in India, but of these, the desert locust, *Schistocerca gregaria* Forsk., is the most important. India has been, from times immemorial, subject to periodical visitations of locust swarms. In Sanskrit literature of the third or fourth century there is a mention of locust menace being one of the most serious calamities that cultivators had to face. Comparatively authentic records of locust visitation are however available only since the beginning of the nineteenth century and according to Cotes (1891) outbreaks occurred in 1812, 1821, 1834, 1843, 1863, 1869, 1878 and 1889. There was another cycle in 1896–97 and in the present century there have been serious invasions of the locust in 1901–03, 1906–07, 1912–15 and 1926–31. Thus there is a certain amount of periodicity in locust outbreaks when swarms appear and cause incalculable damage and destruction to crops, resulting sometimes in severe famines. Due to lack of fodder and pasture, there is heavy mortality among cattle, goats and sheep and sometimes people have to quit their homes in search of livelihood elsewhere. A moderate estimate of damage caused to crops alone during the last cycle (1926–31) was about 2 crores of rupees. Locusts usually remain active for several years in succession, ranging from 3–8 years. Generally their depredations are confined to north-western India but in some years, as during the last invasion of 1926–31, the swarms spread as far as Bengal and Assam in the east, and Madras in the south.

The outbreak areas of locust swarms where the desert locust remains and breeds permanently, lie in a vast desert tract, extending from Rajputana to the west coast of Africa (Text-Fig. 1). Investigations carried out for 8–9 years (1931–39) have shown that in India, permanent breeding grounds of this locust are in the desert

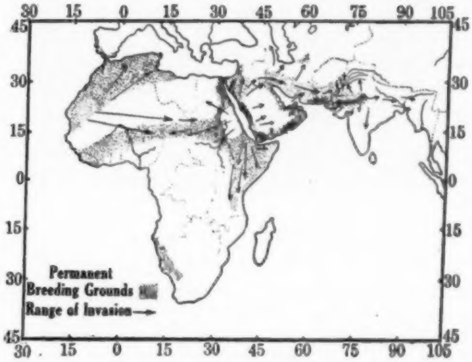

FIG. 1

Permanent breeding grounds of the Desert Locust and range of its invasion

regions of Rajputana, Sind, certain areas of Khairpur and Bhawalpur States and the coastal area of Lasbela and some parts of Kalat State in Baluchistan. These otherwise dry and desert tracts (Text-Fig. 2) become

FIG. 2

Pasni Reks, a desert area in South Baluchistan, where an important out-post of the Locust Warning Organization is situated

green with mostly wild vegetation after rainfall (Text-Fig. 3) and support locust breeding. Generally locust population is not heavy and cultivators and general public are hardly aware of it. When thus scattered about and rather inactive in movements, the locusts are said to be in the solitary phase. However, if the rainfall is abundant in the permanent breeding grounds and other meteorological conditions are favourable, the locusts multiply very rapidly, giving rise to immense swarms which fly actively, leave the desert homes and invade

FIG. 3
Pasni Reks after rains (the scrub vegetation gives out lot of foliage)

the neighbouring parts of the country. This active phase of locusts in which they have the tendency to move in mass-flights is called the swarming or gregarious phase. The cycles of locust visitations referred to above are when the locust was in this phase.

General Biology of the Locust

The desert locust, like common grasshoppers, has three distinct stages in its life-history: (1) egg; (2) hopper, the name given to the young wingless individual, which moves about by hopping; and (3) adult or flier.

The freshly emerged fliers of swarming phase are pinkish in colour, but after a fortnight or so (during spring and summer) they become sexually mature, when they assume a distinct yellow colour. The adult locusts of the solitary phase are grey and are only slightly yellowish when mature.

The adult locusts although very active during the day usually do not fly during the night and on cloudy days. After sunset they generally settle down on crops and trees and feed on them. Most of the damage is thus done during 5 p.m. to 10 a.m.

The female lays eggs in moist soil, preferably soft, sandy or loose soil, after drilling a 3" to 6" deep hole with its abdomen. During her life-time a female has been observed to lay as many as eleven clusters containing 60 to 120 eggs each at an interval of about one week, so that the total number of eggs laid by a female may be over 800.

The eggs generally resemble rice grains. They hatch in about 2 weeks in summer and in 3 to 4 weeks in spring and autumn, depending on temperature and soil moisture.

Hoppers.—The hoppers of the solitary phase possess uniformly green colour throughout their life which harmonises with the colour of the food plants in which they conceal themselves. They do not form bands. The hoppers of the swarming phase are almost black during the first 2 to 3 stages but later develop yellow and greenish-yellow colour with black markings. They collect together to form bands and move in columns. The two phases mentioned above are interchangeable. If the swarming phase hoppers are thinned out by control operations or other adverse conditions and live an isolated life, they assume characters of solitary phase; on the other hand if solitary phase hoppers are massed together, they develop swarming phase characters.

The hopper or wingless stage lasts from 6 to 8 weeks in spring and 4 to 5 weeks during summer.

Nature and Extent of Damage

Immense destruction is caused by fliers but more so by hoppers. There are very few plants which are not eaten by locusts. They are capable of consuming the entire vegetation of a locality, devastating crops, completely defoliating and denuding fruit and shade trees. In the case of hoppers, the activities extend still further. They invade houses, enter kitchens, store rooms, etc., and make life miserable. Sometimes they fall into wells in millions and render the water unfit for drinking purposes. At times the hoppers block railway traffic for hours by making the line slippery on account of their crushed bodies. Since they remain restricted to particular places, the intensity of damage is more severe than in the case of adults which fly off from place to place.

Temperature affects considerably the activities of hoppers as of fliers. The hoppers are sluggish during cool hours of the day. At night they rest in bushes and in the morning when it becomes warm, they begin to march in large bands. They do not ordinarily change their direction of movement, but follow their path relentlessly.

Permanent Breeding Areas in India

There are two main permanent breeding areas in India:

(1) Desert area of Baluchistan—spring breeding area, which receives rainfall generally in winter.

(2) Desert areas of Sind-Rajputana—summer breeding area, which receives rainfall during summer.

The overwintering locusts start breeding in the desert areas of south Baluchistan

(Mekran) after winter rainfall, as soon as the weather conditions begin to warm up in February. The adults of first generation are produced by about middle of April. If the rainfall is also received in the interior of Baluchistan or the soil conditions are suitable otherwise for oviposition, as is sometimes the case in Kulanch, Kolwa and Kachhi areas, there may be another generation in May–June. Majority of these locusts then gradually migrate eastward, to Sind–Rajputana area, where they start breeding again on account of monsoon rainfall received during summer months. There may be two generations in the area if the conditions are favourable. Population of the locusts in this region rises during September–October, after which the adults migrate back to the winter-rainfall area, *i.e.*, Baluchistan, ready to breed during next spring.

It may be added that Arabia and Iran and other adjoining countries in the west resemble Baluchistan with regard to time of locust breeding and like the latter are sources of locusts received in Sind–Rajputana during summer.

The cycle of breeding and migration described above goes on year after year till suitable conditions, particularly rainfall, in either or both the breeding grounds help in mass multiplication and changing of the solitary into swarming phase. In the swarming phase, the distribution is unlimited and as already stated locusts reach distant provinces like Bengal and Madras.

Inauguration of Swarming Phase in 1940

After the last locust cycle ended in India in 1931–32, the locust was found for nine years in the desert tracts of Baluchistan, Sind and Rajputana in the solitary phase. In the summer of 1940, there was a change from solitary to the gregarious phase and the centre of development of this change was in Sind–Rajputana. A brief history of this change of phase is as follows:—

In the Persian Gulf coast of Mekran (Baluchistan), the highest population of overwintering locusts in the beginning of 1940 was about 240 per sq. mile, while very few specimens were traceable in the hinterlands. After the winter rainfall (about 2·25") received in the coastal areas and Kolwa valley in January and February, the locusts started ovipositing towards the end of February. Breeding was rather light and scattered. The hoppers emerged during the first week of March and completed their life-cycle by the middle of April. Scattered breeding was reported up to the middle of May. The population of adults of the spring generation was low. In Kachhi area (Kalat State), the population was 2,560 per sq. mile in June. The adults of the spring generation were all of the solitary phase.

From the foregoing, it is clear that the locust population in all the permanent breeding areas in Baluchistan in the spring and early summer of 1940 was not appreciably high, and nowhere was any incipient swarming observed.

In the desert tracts of Sind and Rajputana the locust population was lower than even in the previous year up to May 1940. Immigrants from the west began to appear in this area early in June as usual. The migrant forms were of grey colour and of solitary phase. Owing to the widespread precipitation received in May and June, the soil moisture conditions all over Sind–Rajputana became suitable for oviposition. In July hoppers of I–V stages in fair numbers were observed in Thar-Mallani parts of Sind, Jaisalmer, Jodhpur and Bikaner States. A further influx in locust population presumably as a result of some more migrants from west was recorded in July and the population density shot up to 8,000 per sq. mile in Thar–Mallani area and 2,080 in Bikaner State. A somewhat remarkable feature observed in this month was that a large proportion of the locusts from some localities showed intermediate and gregarious characters. Besides this, small loose swarms of sexually mature yellow locusts (of gregarious phase) appeared in Suratgarh and Lunkaransar tehsils of the Bikaner State in the second week of July and again early in August. Some of the yellow locusts were seen in north Jailsalmer also in the end of August and first week of September and later on spread to the south and south-west in this area. Concentrated oviposition, presumably took place over a wide area in Bikaner and Jaisalmer States and in Tharparkar district of Sind and the hoppers emerging in September bore gregarious characteristics and the adults which developed from them were pink in colour and formed swarms in the beginning of October.

It is rather difficult to accurately determine the origin of the yellow locusts of gregarious phase which appeared in Bikaner State in July. Judging from the poor breeding in the previous spring in Baluchistan it is clear that these swarms did not originate from

that area. On the other hand, the conditions being extremely favourable for crowded breeding in Sind–Rajputana in early summer on account of patchy vegetation after the prevalence of drought conditions for several years, it is possible that concentrated oviposition took place in some sparsely populated areas by grey migrants or indigenous adults in the end of May, leading to the development of gregarious individuals, which on obtaining sexual maturity became yellow. If this be so, it is evident that in case the conditions are favourable, the desert tracts of Sind–Rajputana can serve as an outbreak centre independent of Baluchistan.

The other source of origin of the gregarious individuals described above may be extra Indian. The history of immigrant swarms in Rajputana–Sind during 1941 shows that this source was really very important, but due to war conditions no information was or is available from foreign countries for the first half of 1940, except for a newspaper report in May that eastern Iraq was threatened with locust invasion.

The swarms, which originated in October–November 1940, from Bikaner and Jaisalmer States in Rajputana and Tharparkar district of Sind, flew towards the west and north-west and visited southern and western districts of the Punjab and N.W.F.P., North Sind and Baluchistan. Apparently some swarms went further west into Iran, Oman (Arabia), etc. Some flew towards the east visiting some southern and central states of Rajputana, south-eastern districts of the Punjab and some western districts of United Provinces. The swarms were most active in November and their activities continued up to January 1941.

In order to discover the overwintering areas of the swarms, the staff of the Locust Warning Organization, assisted by some other research staff of the Imperial Entomologist, carried out intensive and extensive surveys from December 1940–February 1941, of the areas visited by the swarms. In all these areas locusts were traceable, the maximum locust population on the Mekran coast was 26,000 per sq. mile, in Jhalawan 10,000 and in Kachhi 77,000. In Sind–Rajputana the highest population was 21,000 at Arjansar (Bikaner State). Spring breeding (1941) was particularly heavy in Jhalawan and Kachhi areas of Baluchistan, where soil remained suitable for oviposition up to the end of May owing to favourable rainfall and periodic flood waters received in that region. In Mekran the winter-spring precipitation was rather deficient, and therefore, there was only light breeding in most of the localities except in Dasht-Gwadar area, where owing to sufficient rainfall in February, hoppers in large numbers were observed in March and April 1941. Control operations were carried out mostly under the direction of the Locust Warning Organization in Mekran, Jhalawan and Kachhi (Kalat State) with the help of labour provided by the Baluchistan Administration. In Kachhi very heavy concentrations of overwintering locusts were traceable in the cultivated fields. Oviposition occurred in March and hoppers were observed about the middle of April. In some areas the hopper population was 78,00,000 per acre. About 50 per cent. of the IV–V stage hoppers were of gregarious phase. Several lakhs of adult locusts and millions of hoppers were destroyed by beating, baiting and burning and thereby the population was reduced considerably. In spite of the large breeding capacity of the locust, the maximum population in June 1941 was only 11,000 per sq. mile. Thus by continuous and systematic control work the population was reduced considerably and incipient swarming prevented. Therefore the chances of eastward migration of adult locusts to Rajputana were reduced to the minimum.

From the foregoing it is clear that there was no incipient swarming in Baluchistan during the last spring and early summer which is one of the important sources for the swarms for Rajputana and other parts of India. However, between the end of June and the first week of August two principal waves of immigrant swarms came from countries beyond the western borders of India. They flew over the whole of Rajputana and Western India States, touching Hissar in the east and some western districts of the Punjab in the north, but they laid eggs mostly in the Lasbela State (Baluchistan), Tharparkar district (Sind), Cutch and Tharad States (Western India), western parts of Jodhpur State and south-western parts of Jaisalmer State, etc., which received fair amount of rainfall in August–September. Active breeding was in progress in these areas during July, August and September. Oviposition took place on several occasions and by the end of August hoppers of all stages were met with. The hoppers started becoming adults from the

end of August onwards. The largest number of home-bred swarms originated from Tharparkar district of Sind, but Lasbela, Cutch, Jaisalmer and some areas in Rajputana have also contributed some swarms. The swarms, which have originated from Sind, Lasbela and Jaisalmer, have mostly flown in north and north-east direction and invaded the cultivated areas of North Sind, Khairpur and Bhawalpur States, south-eastern districts of Baluchistan and southern and south-western districts of the Punjab. The swarms originating from eastern Rajputana States also flew mostly from south-west to north-east and have visited Alwar, Hissar, Muttra and Aligarh districts in the east, and in the southern direction the swarms have flown over Bhopal and Indore in Central India and Hoshangabad, Nagpur and some other districts in the Central Provinces. So far detailed information has not been received about the areas of oviposition outside Rajputana by these home-bred swarms, but it appears that eggs have been laid in parts of Sind, Alwar State, Gwalior, Muttra and Aligarh districts of the United Provinces.

As the oviposition by the first batch of swarms took place in several series and breeding of second generation also started about the middle of September, it appears swarms will originate right up to the end of October, if not a few weeks later, unless the weather suddenly cools down. Last year the swarms continued to be active in north-west India right up to the end of December and restarted their activity in February.

Locust Control Organizations

The Government of India have a permanent Locust Warning Organization which is always engaged on the study of the rise and fall in the population of the locust, even when it is in the solitary phase, in different desert areas of North-West India. The staff of this organization carefully studies the conditions under which the locust lives and changes into the gregarious phase. As soon as the organization observed the locust in the incipient swarming phase last year, it warned all the Provinces and States likely to be invaded, of the possibility of the inauguration of a fresh locust cycle. Under the advice of the Central Locust Warning Organization, Governments of various Provinces and States established the locust control organizations, mostly consisting of Revenue Officers, the superior officers of which have been trained by the Central Locust Warning Organization in anti-locust work. These regional organizations have carried out extensive control work during this year. The Central Locust Warning Organization, apart from rendering help in the field in the choice of suitable control methods, has been keeping, from its headquarters at New Delhi, all the Provinces and States, informed of swarm movements and the intensity of breeding in various areas. In view of timely warnings, crops have been saved from considerable amount of damage and the saying 'forewarned is forearmed' has proved very true in the control of this pest.

INDUSTRIAL RESEARCH FUND

THE resolution recommending "that a fund, called the Industrial Research Fund, for the purpose of fostering industrial development in this country, be constituted and that provision be made in the budget for an annual grant of Rs. 10 lakhs to the Fund for a period of five years", moved by Sir A. Ramaswami Mudaliar, was accepted by the Central Assembly at its session, on the 14th November.

Sir A. Ramaswami Mudaliar explained in detail the valuable work carried out by the **Board of Scientific and Industrial Research**, since its inception 18 months ago, under the able guidance of Sir S. S. Bhatnagar. The Government considered that it was time that a separate fund be constituted for Scientific and Industrial Research, to place it on an independent and permanent footing. The Commerce Member payed a warm tribute to the work of Sir S. S. Bhatnagar and scientists all over the country, who have successfully investigated several problems of practical interest presented to them. The constitution of the Industrial Research Fund, which will be administered by a Board of Trustees consisting of some officials and prominent scientists and industrialists, will place the Board, more or less on a prominent footing and render possible the expansion of its activities.

LETTERS TO THE EDITOR

A NOTE ON THE SPECIFIC HEAT OF α QUARTZ

MY attention has recently been drawn by a private communication from K. S. Pitzer, Department of Chemistry, University of California, to a paper by C. T. Anderson[1] on the heat capacities of quartz between 50° K. and 300° K. which I overlooked before. In my previous paper[2] on the subject the observed values of C_p between 23° K. and 273° K. were taken from Sosman's book (page 314) on Silica. These were obtained from an extrapolated curve between heat capacity and temperature drawn from the observations of several workers. Between 123° K. and 273° K. the course of the curve is not certain.

The figures given by Anderson are the heat capacities per gram formula weight of SiO_2, and are to be divided by 60 to get the value of C_p. The values for the following temperatures were obtained from a smooth curve between heat capacity and temperature drawn from his observations.

There is not a very marked difference between Sosman's values and those given by Anderson; however the latter show better agreement with the calculated values.

TABLE I

Temperature on the absolute scale	Anderson's value of heat capacity per gram formula weight	$C_p \times 10^3$	Sosman's value of $C_p \times 10^3$	Author's calculated value of $C_p \times 10^3$
50	1·390	23·2	23·5	25·9
73	2·500	41·7	41·0	44·9
92·6	3·445	57·4	56·9	59·6
123	4·810	80·2	77·4	81·2
173	6·895	114·9	111·4	113·8
223	8·620	143·5	141·2	141·2
273	10·030	167·2	166·4	166·0

BISHAMBHAR DAYAL SAKSENA.

D. A. V. College,
Cawnpore,

October 14, 1941.

[1] Anderson, *J. Amer. Chem. Soc.*, 1936, **58**, 568.
[2] Saksena, *Proc. Ind. Acad. Sci.*, 1940, **12 A**, 93.

A NON-FERMENTING TYPE OF THE TEA PLANT, *CAMELLIA THEA*, LINK.

RECENT experimental work with methods of tea selection has made much progress in most tea producing countries. The selection of the highest yielding bushes in different field groups has been the first approach followed by vegetative methods of propagation from selected plants. Selected high yielding tea plants however require weeding out on a quality basis, *i.e.*, on the quality characteristics of the tea made from each bush. The best quality bushes with the most desirable characters are not necessarily the highest yielders. The leaf yield at each harvesting from each single bush being so small in proportion to quantities of tea leaf manufactured commercially at each occasion, a special method of manufacture to deal with leaf from each bush, weighing up to 25 grams comprising about 40 individual shoots, has been devised. This method[1] for single bush manufacture was tested by carrying out a series of successive manufactures of flush from four pairs of different bushes. The method was found to be very satisfactory and even small quantities of withered leaf weighing 10 grams each were satisfactorily manufactured. The results obtained were highly consistent, the same differences of quality inherent in the different bushes being recognised by a tea taster in the samples from successive manufactures.

The bushes of each pair were adjacent to each other. Each of the four pairs tested were mature bushes, six years old, each pair originating from split seedlings and thus being identical. The leaf from each pair was gathered on the same day and manufactured separately. The flush from one pair after passing through the rolling process remained green and unfermented. The fired tea on infusion showed a very green infusion and the liquor was thin and green. The green character of the liquor was that of pungent, unfermented tea tannin. The other three pairs of bushes fermented normally. The fired teas on infusion exhibited normal characteristics of infusion and liquor. The leaf from both non-fermenting bushes was manufactured at varying degrees of wither with combinations of fermentation periods extending from six to twenty-four hours. The leaf remained in all cases green and unfermented.

The discovery of the non-fermenting character in each of the two bushes originating from the same split seedling reveals the existence of a genetical factor for fermentation which has not hitherto been taken into account. Further investigations have shown that there are many types of tea ranging from non-fermenting types through poor and medium types to types which ferment with extreme rapidity. That this factor is connected with the presence or absence of an oxidising enzyme system[2] has been recently demonstrated by the addition of oxidase preparation to non-fermenting leaf thus inducing normal fermentation.

P. R. PERERA.
Tea Research Institute of Ceylon,
St. Coombs, Talawakelle,
August 30, 1941.

1 *The Tea Quarterly*, 1940, **13**, 43.
2 *Biochemical Journal*, **34**, 1488.

PERMANENT LABELS FOR MICROSCOPE SLIDES

IN tropical countries paper labels on slides are liable to peel off owing to the humid air or to the large variations of temperature; most inks are liable to fade in strong light; fungi and insects, too, particularly the fish insect, attack the gum or the paper of the label; some insects scrape off the writing alone.

Dipping the paper label in some poisonous solution such as mercuric chloride protects it temporarily against fungi and insects but not against peeling off. For this last difficulty I have tried with success a thin paint of cellulose solution in amyl acetate applied with a brush in two or three coats. This preparation is commonly available in collapsible lead tubes under the trade name of "Duco cement". When applied thin it dries up almost immediately and forms a transparent and invisible

film extending beyond the edge of the label, which it thus further helps to fix to the slide.

For thin sections of fossil plants I have, however, found the following procedure excellent.

Grind with fine abrasive powder the part of the slide which you want to label, so as to remove the polish. On the ground surface you can write the label freely with a fine pointed lead pencil which should preferably be a hard one. Then place a drop of Canada Balsam on the writing and put on a coverslip. The Canada Balsam spreading under the coverslip at once makes the previously opaque ground surface transparent, leaving the pencil writing beautifully legible on a clear background. If the coverslip is surrounded by a border of the opaque ground surface the effect is elegant.

Obviously, this method has wider possibilities. For instance, it can be employed with advantage in labelling larger exhibits kept in glass show cases: the glass pane can be labelled on the inside, with the data written not on the pane (which would necessitate inverted writing) but on the coverglass itself. To make its surface receptive to the lead pencil the coverglass can be much more easily ground than the pane; for such purposes a thick coverglass, such as an ordinary microscope slide, can be used with advantage.

B. Sahni.

The University,
Lucknow,
October 14, 1941.

AN INDIGENOUS MOUNTING MEDIUM FOR MICROSCOPIC WORK

Before the war, a number of mounting media such as Canada balsam, 'Euparal', 'Diaphane' Glycerine Jelly, 'Karo', 'Clarite' (formerly known as Nevillite V), etc., have been in use in different scientific laboratories for microscopic work with animal or plant tissues. Almost all these are imported products and considerable difficulty has been experienced, of late, in securing adequate supplies of these mountants for class teaching and research work. This prompted an investigation into the properties of some indigenous resins with a view to using them as a substitute for Canada balsam, which is by far the most popular and universally employed microscopic mountant.

Attention was directed to 'Gurjan' balsam (from oil of *Dipterocarpus levis, D. alatus* and *D. turbinatus*), Dammar balsam (from species of *Shorea, Hopea* and *Balanocarpus*; Fam, Dipterocarpaceæ) and Rosin from Turpentine (*P. longifolia, P. excelsa* and other species growing in India). As solvent of the resins, turpentine, benzol and xylol were employed. Trichloroethylene was employed in some preliminary experiments but it has a tendency to make the solution too thin. Hence, its use was discontinued. Chemical analyses indicated that 'Gurjan' oil had a resin content of about 54% with an essential oil content varying from 20–82%, as compared to 66% of resin and 33% of volatile oil of Canada balsam (*Abies balsamea*). It was immediately evident that the high essential oil content in some brands of 'Gurjan' oil with their comparatively low resin content would militate against their use as substitutes for Canada balsam. If the high essential oil content of 'Gurjan' oil is brought down by distillation, the 'Gurjan' balsam may serve as a suitable substitute, but this would involve labour and expenditure not worth while undertaking as an economic proposition. Dammar* balsam (Gum Dummar, as it is sometimes called) and Rosin from turpentine were therefore chosen for more intensive study.

The experiments performed in this connection and the observations made are recorded in tabular form for convenience. In judging the suitability of any particular mounting medium, frequent comparisons were made with (1) standard mounting medium commonly used (*i.e.*, Neutral filtered Canada balsam in liquid form manufactured by Merck & Co.)

* Two varieties are stated to be common in India: (i) One variety indigenous to Bengal and (ii) One to the Malabar coast. It is available in the South Indian Market.

No. of Expt.	Mountant used with quantities	pH	Refractive Index	Solubility	Transparency	Drying power	Retention of stain in stained and mounted tissue specimens	Remarks
1	Rosin + Turpentine (5 gms.) (5cc.)	3·0 to 3·2	1·48	Not good. Better on heating in water bath	Fair	Fair, tendency to crystalize on long keeping and thus spoiling preparation	Tendency for hematoxyline stain to fade away being too acidic	Not suitable
2	Rosin + Turpentine (5 gms.) (5 cc.)	Highly acidic	..	Not good	Fair	..	Same as above	Too thin for a good mount
3	Rosin + Xylol (5 gms.) (5 cc)	Acidic	1·49	Fair	Fair	Not satisfactory	..	Not suitable
4	Dammar + Xylol (5 gms.) (7 cc.)	4·1	1·48	Fair	Fair	Not good	Fair upto 3 months	Cover slip does not stick in 4 days
5	Rosin + Dammar (2 gms.) (3 gms.) + Xylol (7 cc.)	4·2	1·48	Fair. Good on water bath	Good	Fair	Do	..
6	Rosin + Dammar (2 gms.) (3 gms.) + Turpentine (7 cc.)	3·7	1·49	Fair	Good	Comparatively poor	Do	Cover slip does not stick in 7 days
7	Rosin + Dammar (2 gms.) (3 gms.) + Benzol (7 cc.)	4·2	1·477	Fair. Good on water bath	Good	Good	Do	Cover slip sticks in about 4 days. Tendency to get cloudy before mounting
8	Canada Balsam (5 gms.) + Xylol (6 cc.)	Neutral	1·465	Good	Good	Good	Do	Do Disappears on warming slide.
9	'Euparal'	4·3	1·49 to 1·5	..	Good	Good	Intensifies hematoxyline stain	Tendency to cloudiness. Disappears on warming

and (2) 'Euparal' (a combination of Camsal, Sandarac, Eucalyptol and Paraldehyde), an imported ready-made mounting medium which is popular with many English technicians.

It will be seen from the table that a mixture of Rosin and Dammar resin in xylol or benzol (Nos. 5 and 7) appears to be a better substitute than either Dammar + Xylol or Rosin + Xylol. Benzol as a diluent is even better than xylol as it dries more quickly than xylol. There is often a cloudiness when the tissue is first mounted in this medium due to interlocking of air bubbles, but this is easily eliminated by warming the slide gently before adding the cover glass. Turpentine as a solvent for Dammar resin or Rosin has the disadvantage that quite often fractures or minute crystals appear under the cover glass blurring the vision and sometimes spoiling the preparation.

Mounts prepared with No. 7 or No. 5 medium have been found to retain transparency for more than 3 months, for which period observation has so far been recorded, and these do

not fade around the periphery or turn yellow on long keeping as frequently do those mounted in ordinary brands of Canada-balsam, which are often much more highly acidic than this medium. 'Euparal' tends to intensify hæmatoxylin stains but otherwise this medium appears to compare favourably with it in transparency and drying power. 'Euparal' has a higher index of refraction than Canada-balsam but this medium has practically the same refractive index as slide glass, which should be an advantage as far as transmission of light through the medium is concerned.

Microscopists who have not got a generous supply of Canada-balsam or 'Euparal' may give this mixed mounting medium a fair trial and suggest further improvements, if possible. Dammar resin and Rosin are easily available in the Indian market. Dammar is not often readily obtainable in a condition suitable for immediate use. If it is secured in the form of lumps of various sizes mixed with powdered material or debris, the lumps should be picked out, melted over a hot flame in a suitable container, and then the melted balsam poured into the desired solvent (Xylol or Benzol). This may preferably be filtered once or twice through a course filter-paper placed in a ridged funnel.

Our thanks are due to Prof. S. Ghosh, Professor of Chemistry, School of Tropical Medicine, under whose direction the analysis of 'Gurjan' balsam was carried out and to Prof. S. R. Bose, Professor of Botany, Carmichael Medical College, Calcutta, who confirmed the usefulness of this mounting medium in plant tissue preparations.

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ERGOT IN INDIA

The only ergot hitherto reported in India is *Sphacelia sorghi* McRae, described by McRae[1] as the cause of a disease of jowar (*Sorghum vulgare* Pers.). It was suggested by Ajrekar[2] that this fungus is the imperfect stage of a species of *Claviceps*. In September and October 1941, the senior author found a severe attack of ergot on three different grasses in the neighbourhood of Simla at an altitude of 6,500 feet. The appearance of the ergots and conidial measurements on the several hosts were as follows:—

(1) *Brachypodium sylvaticum* Beauv.—Ergots slightly curved, up to 35 mm. long, 1·5–2 mm. diam., "dusky-brown" (Ridgway) in colour externally and "pale pinkish cinnamon" internally; conidia ovoid, $5 \cdot 5 \times 2 \cdot 9$ $(2 \cdot 1–7 \cdot 8 \times 1 \cdot 8–3 \cdot 9)\mu$. Collected October 11th, 1941.

(2) *Oplismenus compositus* Beauv.—Distinctly curved, up to 9 mm. long, 1–1·5 mm. diam., "chaetura black" externally, white internally; conidia ovoid to cylindrical, $5 \cdot 2 \times 2 \cdot 0$ $(3 \cdot 9–6 \cdot 1 \times 1 \cdot 8–2 \cdot 8)\mu$. Collected October 11th, 1941.

(3) *Andropogon* (? *Gryllus* L.).—Very slightly curved, up to 14 mm. long, 1–1·5 mm. diam., "sooty-black" externally and white internally; conidia spherical to ovoid, $5 \cdot 6 \times 3 \cdot 0$ $(3 \cdot 6–11 \cdot 0 \times 1 \cdot 8–4 \cdot 6)\mu$. Collected October 10th, 1941.

In all cases the sclerotia are typical of those of *Claviceps*, and they undoubtedly belong to a representative of this genus.

The species of *Claviceps* cannot be determined for certainty in the absence of the perfect stage of the fungus. *Claviceps purpurea* (Fr.) Tul. is known to occur on *Brachypodium sylvaticum; C. pusilla* Ces. is known on *Andropogon ischæmon* L. The difference between these two species of *Claviceps* is chiefly in the colour of the stipe and head; the sclerotia of the Simla collections fit well the description of either of these fungi. The collections on the above grasses were made in one vicinity, and all three

may be *C. purpurea* or *C. pusilla*. The conidia are rather large for the former.

Ergots of several species of *Claviceps* are of the greatest economic importance. In the first place they are poisonous to humans and animals if consumed in large quantities. Secondly, from ergot is derived ergotoxine, a most important medical drug, of which at the present moment there is a shortage. The ergotoxine content and the possibility of exploiting the Indian fungus have to be investigated.

PUSHKAR NATH.

Potato Breeding Station,
Simla,

G. WATTS PADWICK.

Imp. Agric. Res. Institute,
New Delhi,
November 4, 1941.

[1] McKae. W., *Madras Agric. Yearb.*, 1917, 109.
[2] Ajrekar, S. L., *J. Ind. Bot. Soc.*, 1926, **5**, 55.

TEMPERATURE VARIATION OF SOUND VELOCITY IN LIQUIDS

IN a paper on the viscosity of liquids Andrade[1] has shown that

$$\eta \propto \frac{\nu}{\sigma} \tag{1}$$

where η is viscosity, ν the frequency of vibration of a molecule of the liquid and σ the intermolecular distance. Wheeler[2] also has given the same type of equation.

According to Rama Rao[3]

$$v \propto \frac{1}{\sigma^9} \tag{2}$$

where v is the velocity of sound in the liquid. Assuming that

$$\nu \propto \frac{1}{\sigma^n} \tag{3}$$

where n is an integer, we get by combining (1), (2) and (3) that

$$\eta \propto v^{\frac{n+1}{9}}. \tag{4}$$

Now, Andrade[1] and others[4] have developed the equation

$$\eta = \mathrm{A}e^{\frac{\mathrm{B}}{\mathrm{T}}} \tag{5}$$

where A and B are constants of the liquid and T the absolute temperature. This equation gives the temperature variation of viscosity and this is true for many liquids. Combining (5) with (4) we get

$$v = \mathrm{L}e^{\frac{\mathrm{S}}{\mathrm{T}}} \tag{6}$$

where L and S are constants dependent on the liquid.

The relation (6) holds good very well in many liquids. When log v is plotted against $\frac{1}{\mathrm{T}}$ for different liquids, straight lines are obtained (Fig. 1) as is to be expected from the relation

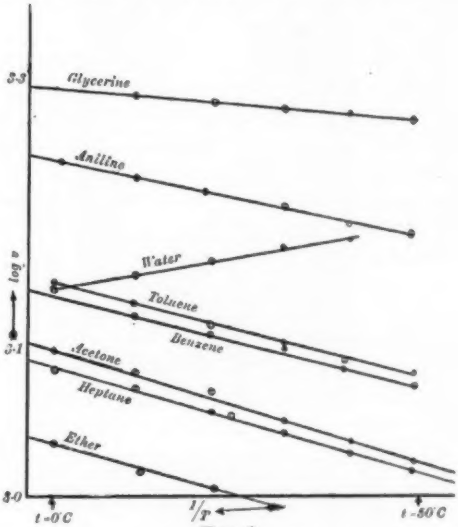

FIG. 1

(6). The constants L and S are not merely arbitrary in character but have some special significance. This is shown by the fact that changes in molecular weight and structure are accompanied by a change in the position and slope of the lines (Fig. 1).

G. SURYAN.

129, Uriopet,
Bangalore City,
June 12, 1941.

[1] Andrade, *Phil. Mag.*, 1934.
[2] T. S. Wheeler, *Trans. Nat. Inst. Sci. of India*, 1938, **1**, 333.
[3] Rama Rao, M., *Ind. Jour. of Phy.*, 1940, **14**, 109.
[4] Venkatarama Iyer. M. P., *Ibid.*, 1930, **5**, 371.

NOTE ON A NEW GENE AFFECTING LEAF SHAPE IN ASIATIC COTTONS*

HUTCHINSON[1] AND SILOW[2] have described in detail the inheritance of leaf shape in Asiatic cottons. In addition to the series of multiple alleles L^L, L^N, L^A L and l giving a range of types from laciniated to broad, there exist two broad leaved allelic members of the same series, L^B and L^l, which arose by mutation in an L^L plant. Their studies have contributed to a valuable discussion of the organisation of a gene locus, and therefore, the new form of

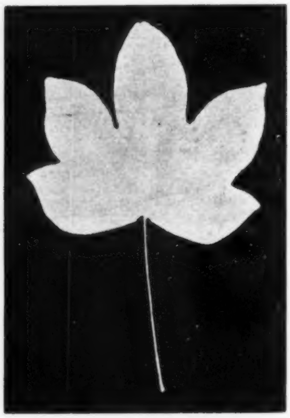

FIG. 1

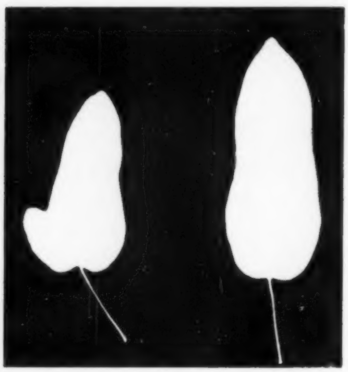

FIG. 2

FIG. 3

FIG. 4

leaf shape reported in the present note should prove of more than common interest.

In all members of the *L* series of alleles, the leaf is characterised by 3–7 lobes (Figs. 1 and 3), the middle lobe being the longest. A type of leaf shape illustrated in the photograph (Fig. 2) arose as a mutant (isolated by Rao Bahadur V. Ramanathan at Coimbatore) in the South Indian variety known as C_7, a form of *G. arboreum* var. *neglectum* f. *indica*. C_7 has a 3-lobed broad leaf (Fig. 1). In the mutant plant, the first one or two leaves are

* The work described in this note is being conducted under the Cotton Genetics Research Scheme, Indore, financed by the Indian Central Cotton Committee.

nearly normal, but later leaves show a progressive reduction of the two lateral lobes resulting in tadpole-shaped leaves and ultimately the leaves consist of only the single middle lobe. In a normal broad leaf, the ratio of length of middle lobe to the length of the lateral lobe ranges from 1·1 to 1·3 and in the mutant measured in the earlier leaves the range is from 1·6 to 2·0. Evidence is presented below to show that the leaf shape gene carried by the C_7 mutant is not a member of the L series of alleles and that normally there is a single factor difference between the single mutant and normal broad. The symbol S – s may be given to the lobed-single pair of alleles.

The mutant, *ll ss*, was crossed to Malvi, *ll SS*, A_1 and Kokati narrow, *LL SS*, A_8, $L^L L^L$ SS and A_9, $L^B L^B$ SS. All F_1s had normal 3–7 lobed leaves showing complete dominance of the lobed leaf over the mutant type of leaf. An F_2 family of Malvi × Mutant single gave 40 normal: 13 single, almost exactly 3 : 1. There is therefore in this cross a single factor difference between normal and mutant.

Four F_2 families of the cross $A_8 \times$ Mutant gave a four-class segregation: laciniated-lobed, laciniated-single, broad-lobed and broad-single. Similarly, in the six F_2 families of the cross $A_1 \times$ Mutant, four phenotypes could be made out: narrow-lobed, narrow-single, broad-lobed and broad-single. The occurrence in these crosses of the four phenotypes involving recombination between L and S loci shows that the S-s gene locus is not a member of the L series of allelomorphs. These phenotypes are illustrated in the accompanying photograph.

The proportions of the four phenotyes in the F_2 families of $A_8 \times$ Mutant and $A_1 \times$ Mutant deviate considerably from 9 : 3 : 3 : 1 expectation. Again, many of the F_3 families of the cross Malvi × Mutant give a significant departure from 3 : 1 expectation, while a few families give a good fit to the expected 3 : 1 ratio. Further work to elucidate the genetics of the single mutant is in progress.

We are indebted to Rao Bahadur V. Ramanathan, Cotton Specialist, Madras, for kindly supplying seeds of the mutant.

K. RAMIAH.
BHOLA NATH.
Cotton Genetics Research Scheme,
Indore,
November 7, 1941.

1 Hutchinson, J. B., *J. Genet.*, 1934, **28**, 437.
2 Silow, R. A., *Ibid.*, 1939, **38**, 229.

THE INHERITANCE OF PURPLE PIGMENT AT THE BASE OF ANTHERS IN SORGHUM

IN almost all cultivated sorghums the fresh anthers are yellow in colour. The inheritance of purple pigment occurring in the anthers of a few African varieties of sorghum has been recorded.[1] They have been noted to have their grain either brown or have the factor for brown as evidenced by the colour of the dry anther.

Most of the Asiatic sorghums have yellow or light yellow anthers with no purple on them. In a South Indian variety of *Sorghum dochna* with its anthers light yellow and grain white, there occurred in 1925 a heterozygous mutant with brown grains and the base of the anthers coloured purple. There was no other type with purple-based anthers in the whole of the Coimbatore collection. This mutant was sown and segregated giving 129 plants like the mutant and 37 like the mother type. In subsequent generations there was the usual repetition of monohybrid segregation, the total of 8 families being 973 plants with brown grain and purple at the base of the anthers, and 320 plants with white grain and mere light yellow anthers. A type pure for purple at the base of the anthers and brown grain has been fixed, and is constant for this character. The hybrid of the cross between this new type and the mother type segregated into brown grain with purple-based anthers and white grain with no purple in the anthers in the proportion of 3 : 1, the other characters remaining pure. It is remarkable that every plant with the base of the

anther purple had its grain brown. No white grain occurred in plants with purple-based anthers.

A gene designated A_b is responsible for the manifestation of purple colour at the base of the anther. The ordinary non-purple pigmented yellow anther has the gene a_b There is a very close association between A_b and one of the two B factors[2] responsible for the production of brown colour in the pericarp of the sorghum grain.

G. N. RANGASWAMI AYYANGAR.
M. A. SANKARA AYYAR.
A. Kunhi Koran Nambiar.
Millets Breeding Station,
Coimbatore,
November 6, 1941.

1 *Proc. Ind. Acad. Sci.*, 1938, **8**, 317.
2 *Ind. Jour. Agri. Sci.*, 1934, **4**, 81.

THE INHERITANCE OF DEPTH OF GREEN COLOUR IN THE LEAVES OF SORGHUM

IN the world collection of sorghum varieties grown and studied at the Millets Breeding Station, Coimbatore, it was noticed that the varietal blocks varied in the depth of green colour in mass effect. Three distinct groups could be made out. The commonest was the Green. The other smaller groups were Dark Green and Light Green. The three tints of green have proved to be varietal characteristics and remain constant through years. Being a mass-effect character, its pursuit in inheritance through individuals is beset with difficulties. From experience it has been found that the best time to read the character is when the plants are 5 to 6 weeks old. Before and after that period the differences tend to blend, and make classification dubious. When grown in mass, differences could always be made till the leaves begin to desiccate with age. An estimation of chlorophyll content showed that the green and dark green contained 17 and 22 per cent. more chlorophyll than the light green. There was more of chlorophyll *a* in light green and more of chlorophyll *b* in the other two groups.

The broad distribution of the three types among the groups of sorghums, both wild and cultivated, is as follows: Dark green—All wild sorghums except the Para sorghums, and most of the African varieties. Green—The Para sorghums and the Indian varieties. Light green—Chinese varieties. Typical of the three grades are the African Caffra sub-series for dark green, the Indian Durra sub-series for green, and the Chinese *Sorghum nervosum* for light green. Sorghums intercross freely and there have been varietal migrations with the result that stray combinations of other characters with the three leaf tints, are naturally met with.

To determine the inheritance of this character, crosses among the three types were made and the results are given below. The first cross was between A.S. 3464 (dark green) and A.S. 367 (green). The F_1 was dark green. The segregation in the F_2 (total of 6 families) gave 749 dark green and 244 green plants. In the F_3, out of 23 selections of dark green sown, 7 bred pure and 16 segregated again giving a total of 1,003 dark green and 334 green plants. All the 6 green selections bred pure. The second cross was between A.S. 367 (green) and A.S. 1741 (light green). The F_1 was green. The F_2 (family A.S. 6731) segregated and gave 138 green and 46 light green plants. In the F_3 generation, of the 3 selections of green, one bred pure, and the other 2 segregated giving between them 232 green and 66 light green plants. The third cross was between A.S. 3872 (dark green) and A.S. 1741 (light green). The F_1 was dark green. The F_2 (family A.S. 6730) segregated for all the three types giving 150 dark green, 84 green and 13 light green plants, a 9 : 6 : 1 ratio. In the F_3 generation, of the 6 selections of dark green sown, one bred pure, 3 gave a total of 263 dark green, 172 green and 25 light green plants, and 2 gave 181 dark green and 63 green plants. Of the 4 selections of green, 2 bred pure and 2 gave 108 green and 34 light green plants. The only selection of light green sown bred pure as expected.

From the above data it will be noticed that in the leaf colour of sorghum, Dark Green is a monogenic dominant to Green, and Green a monogenic dominant to Light Green, and that when there is segregation for all three characters, the ratio is 9 : 6 : 1 of Dark Green, Green and Light Green. Two supplementary factors for chlorophyll colour—C_1 and C_2—operate. Either of them can deepen Light Green into Green. Both of them have to be present to produce a Dark Green type.

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November 6, 1941.

PITYROGRAMMA CALOMELANOS, LINK., IN BENGAL

Pityrogramma calomelanos, Link. (Syn. *Gymnogramme calomelanos*, Kaulf.; *Ceropteris calomelanos* Und.) is a popular greenhouse fern introduced into cultivation from the West Indies about 150 years ago; but there is no mention of it in the older works and papers on Indian ferns.

Writing in 1922, Blatter and d'Almeida[1] stated that it had run wild in and about Bombay and was becoming naturalized in the Nilgiris. Its occurrence in the district of Purnea (Bihar) was recorded by Haines[2] in 1924. In 1930 Mehra[3] found it growing abundantly in a state of nature in certain parts of Sikkim. In a letter to Dr. P. Maheshwari (2-7-41), Dr. S. K. Mukerjee, Curator of the Herbarium, Royal Botanic Garden, Sibpur, states that from a sheet preserved there, it appears that the plant was collected in a wild state from Kurseong as early as 1921, that Dr. K. Biswas recently collected it from the roadside at Rorathang in the Darjeeling district, and that it has also been recorded from Mercara, Coorg.

No record thus exists of the plant having hitherto been collected anywhere in the plain districts of Bengal. It will therefore be of interest to note that in the course of a collecting tour in the district of Chittagong in September and October, 1940, the writer discovered the plant growing wild in the town of Chittagong and that it has also been found growing unrecognised on the walls of two fernhouses at the Government Nursery, Dacca.

Although of American origin, this fern has, according to Holttum,[4] become well established in Asia, the wind having apparently played a considerable part in the dispersal of spores as strikingly demonstrated in the case of the reappearance of vegetable life on the volcanic island of Krakatoa (Krakatau) in the Dutch East Indies after the great and destructive eruption of 1883. At Chittagong the plant was found to occur rather sparingly on the sides of certain ravines and cuttings, mixed with other vegetation, the spores having in all probability been derived at some time or other from cultivated plants in the bungalows on the tops of the neighbouring hillocks. At Dacca the spores or prothalli must have originally come with pots of other pteridophytes obtained for the Nursery. Only a couple of plants were noticed here during the rains of 1940, but they have since been gradually spreading in the neighbourhood.

It may be incidentally mentioned here that Underwood was the author of the combination "*Ceropteris calomelanos*" and not Linnaeus as stated by Mehra in his paper and the correct citation should have been "*Ceropteris calomelanos* (L.) Und."; the name now accepted is that given at the head of this article.

S. K. Sen.
Biology Department,
Dacca University,
September 30, 1941.

1 Blatter, E., and d'Almeida, J. F.; *The Ferns of Bombay*, 1922.

2 Haines, H. H., *The Botany of Behar and Orissa*, 1924.

3 Mehra, P. N., *Ceropteris calomelanos* L. in Sikkim, *J. Ind. Bot. Soc.*, 1932, **11**, 340.

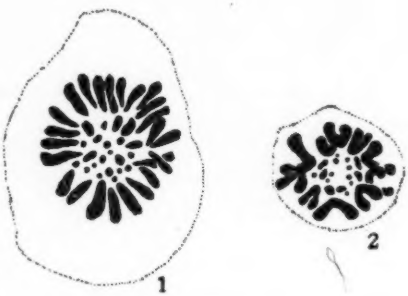
4 Holttum, R. E., *Ecology of Tropical Ferns* (in "Manual of Pteridology" by Verdoorn), 1938.

SPERMATOGONIAL CHROMOSOMES OF TWO INDIAN LIZARDS, *HEMIDACTYLUS FLAVIVIRIDIS* RÜPPELL AND *MABUYA MACULARIA* BLYTH

In a previous note to this *Journal*[1] we have given an account of the chromosomes of an Agamid lizard, *Calotes versicolor* Boulen., the common blood-sucker. In the present note we propose to give an account of the spermatogonial chromosomes of two more Indian lizards, *Hemidactylus flaviviridis* Rüppell (Family Gekkonidæ) and *Mabuya macularia* Blyth (Family Scincidæ). The first mentioned species is more commonly found inside human dwellings than outside all over Northern Gujarat and is one of the 17 species of that genus described by Smith.[2] The other lizard also is common in this region. It usually hides itself below stones or takes cover under grass and rotten foliage of trees like *Salvadora persica*. It frequently takes shelter in the shady parts of the hedges formed by *Euphorbia neriifolia* and *Capparis sepiaria* on the sandy tracts of Northern Gujarat. According to the observations made by one[3] of us the breeding season of *Mabuya macularia* Blyth extends from about the middle of July to mid-September. The colouration of the species, particularly of the male, undergoes a marked change in this season. The underside of the throat and most of the anterior half of the body is transformed into brick red from pinkish white.

The periodicity in the male gonads of these two lizards has been studied and the histological changes in them have been followed. The object of the present note, however, is to give a brief account of the chromosomes in the primary spermatogonia of these two lizards.

The male gonads were fixed all the year round at night between 11 p.m. and 5 a.m., as in the case of *Calotes*, in Oguma's fixative, Flemming with acetic acid, Bouin, Allen and Bouin and dehydrated by the usual methods. It was cut into sections 10–12 micra thick and stained with Heidenhain's iron-hæmatoxylin. The sections were differentiated with a saturated solution of picric acid. The first one of these fixatives proved to be very helpful in the case of *Hemidactylus*. Figs. 1 and 2 show the polar view of the spindle in the primary spermatogonia of *Hemidactylus flaviviridis* and *Mabuya macularia* respectively.



Hemidactylus flaviviridis Rüppell.—Polar view of spermatogonial metaphase plate. × 2,000 approx.

Mabuya macularia Blyth.—Polar view of spermatogonial metaphase plate. × 2,000 approx.

It will be seen from Fig. 1 that there are 46 chromosomes in the chromosomal complex of *Hemidacatylus flaviviridis* and that this garniture is made up of two classes of chromosomes, rod-shaped macrosomes and small dot-like microsomes. There are no V- or J-shaped chromosomes in the complex of this lizard and this is in conformity with the observations of Nakamura[4] (1931) on some other forms belonging to this family. The macrosomes are usually 24, but sometimes 23, and lie at the periphery of the spindle. Inside these there are small rods which show gradual diminution in size and pass through imperceptible gradation into microscmes. The number of dot-like microsomes is 12 (13 in the case of those plates where there are 23 rods at the periphery) and these lie in the central part of the plate. All the chromosomes are attached terminally.

In a primary spermatogonium of *Mabuya macularia* there are 26 chromosomes made up of three classes of elements as follows (Fig. 2):—

(1) 10 V-shaped chromosomes distributed at the periphery of the spindle and attached atelomitically;

(2) 6 batonnets attached terminally but lying inside the ring formed by 10 V-shaped macrosomes;

(3) 10 small dot-like microsomes occupying the central part of the metaphase plate.

The batonnets as well as dot-like microsomes are attached terminally to the spindle fibres. The chromosomal complex of this skink conforms to *"le complexe scinco-lacertoide"* of Matthey[5] (1931).

A careful analysis of the chromosomal complexes of these two lizards has revealed some noteworthy features in which these complexes resemble those of other lizards we have studied which we hope to discuss elsewhere.

J. J. Asana.
T. S. Mahabale.

Gujarat College,
Ahmedabad,
October 20, 1941.

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1 Asana, J. J., and Mahabale, T. S., *Curr. Sci.*, 1940, **9**, 377.
2 Smith, M., *Fauna of British India, including Ceylon and Burma, Reptilia and Amphibia*, **2**, *Sauria*, London, 1935.
3 Asana, J. J., *Proc. Ind. Sci. Cong.*, 1932, **19**, 266.
4 Nakamura, K., *Cytologia*, 1932, **3**, 156.
5 Matthey, R., *Rev. Suisse De Zool.*, 1931, **38**, 117.

DISCOVERY OF CELESTITE IN THE TRICHINOPOLY DISTRICT

In connection with the note published in *Current Science* of June 1941 (p. 299) above the signature of Dr. N. Jayaraman, I may be permitted to make the following observations.

I now learn that the lump of celestite referred to was entirely different from the one given by the *Trichinopoly Mining Works, Ltd.*, to a member of the staff of the Indian Institute of Science, and the firm's belief in the identity of the two was mistaken. Dr. Jayaraman may therefore be credited with the rediscovery of the mineral by himself. The firm does, however, claim that its agents found the heavy mineral (known to them later as celestite) in their gypsum area around Karai in or before January 1939.

Regarding the area to which Dr. Jayaraman's estimates refer, I quote here the relevant paragraph from his announcement in the *Hindu* of 4th January 1940.

"Mr. Jayaraman, who has just returned from a survey of the newly found deposits, states that the minerals (*i.e.*, celestite and strontianite) occur in a free state in considerable quantities over a large region and particularly rich *in an area of* 1,500 *acres in Karai village* near Utatur. On a rough preliminary survey it is estimated that *this* area contains about a million tons of celestite and strontianite (Italics and parentheses mine).

Reading the above, I was naturally led to the conclusion that the area in question was the 1,500 acres around Karai, and not the larger region. However, Dr. Jayaraman has since explained that he meant the larger region.

I freely admit that I was inaccurate in stating (in my report published by the Madras Government as Development Department G.O. 735 dated the 10th April 1941) that Drs. Krishnaswami and Jayaraman reported the presence of celestite *and strontianite* in the cracks of phosphatic nodules. That the error was inadvertent will be shown by the fact that I have reported these authors correctly in the Geological Survey Bulletin No. 2 on Strontium.

Ignoring Dr. Jayaraman's sarcasm about 'rough hammer tests' which unfortunately no field geologist can dispense with, I may say that Dr. Jayaraman is not justified in making a generalisation about a large area from the examination of the nodules from a limited area, since my field work extending over two months in that region led me to different conclusions. Dr. Jayaraman's last sentence regarding the sparseness of distribution of strontium carbonate is now a welcome correction.

M. S. Krishnan.

Geological Survey of India,
Calcutta,
September 9, 1941.

REVIEWS

Mercerising. By J. T. Marsh. (Chapman & Hall, Ltd., London), 1941. Pp. xv + 458. Price 32*sh.*

Mr. Marsh has made a very valuable contribution to the literature of textile chemistry. As stated in the cover page with justification, no book has appeared on the subject for thirty years, although mercerisation has continued to be the most important process by which such qualities of cotton yarn and fabric as lustre and dyestuff absorption, can be improved. The action of caustic soda, and of other reagents capable of producing like effects by their swelling power, on cotton has, however, been studied and reported on in numerous publications in journals. Mr. Marsh's book is a comprehensive survey in which the latest advances have been noted and every aspect of the subject has received adequate treatment. The history of the various discoveries concerning mercerisation, the technology of the process, the methods of examination of mercerised materials, and the theoretical basis, physical and chemical, of the action have all been described with a wealth of detail that makes the book of equal value to the textile chemist in the laboratory and to the practical processer. The latter will find the account of the machinery for yarn and cloth, the discussion of the factors to be controlled during the large-scale operation, the examination of the relative merits of carrying out the mercerising process after various stages of pretreatment, and the quantitative evaluation of the effect obtained, to be of the utmost help in his day to day handling of plant and processes.

A somewhat different arrangement of the chapters and reduction in the length of the book with advantage to clarity could have been suggested. The chemistry of cellulose and its modification or degradation productions has been so fully treated in Doree's "Methods of Cellulose Chemistry" and the author's own recent treatise (jointly with Wood) on the "Chemistry of Cellulose" that it might have been largely omitted from the present volume except in so far as it related to the mercerising process. The statement regarding the reactivity ratio being the only absolute method, or in fact in any sense at all an "absolute" method, is questionable. One aspect of mercerisation which deserves more extensive treatment than the author has been able to give, is the use of wetting or penetrating agents and their relation, with regard to chemical constitution and specific properties, to the wetting agents used in other wet processes for textiles. References to the work of Mark and Meyer and other continental investigators are brief and casual, while there is a tendency to regard the publications of the Shirley Institute (The British Cotton Industry Research Association), extremely valuable and important as they are, as constituting more or less the entire literature of textile research.

The book should find a place in the library of every cotton mill in the country. There is perhaps no process in the conversion of grey cotton to finished fabric which is so badly neglected in our mills as mercerisation, and a perusal of "Mercerising" will be a salutary reminder of the careful study and control of many factors that are necessary if the highest efficiency is desired.

K. VENKATARAMAN.

Canning Practice and Control. By Osman Jones and T. W. Jones. (Chapman & Hall, Ltd.), 1941. Second edition. Pp. 311. 32*sh.*

The appearance of an enlarged edition of this book of recognised practical value is opportune in that it coincides with a close of a decade that has witnessed a phenomenal development in our knowledge of the scientific principles of canning. So rapid has been the progress in scientific canning and the adoption of its recent discoveries to commercial practice that, after only three years of its first publication, a revision of this very useful book became essential. The authors are naturally gratified by the reception accorded to the first edition by canners all over the world. Their experience both in the laboratory and in the factory has, indeed, afforded them an unrivalled opportunity to deal with the subject in all its aspects authoritatively. The enlarged edition contains an up-to-date and exhaustive collection of experimental results so far

obtained on the subject and it will undoubtedly be of lasting value as a reference volume to canners and research workers in this field.

Very little of the first edition has been modified, but considerable additions have been made particularly to chapters VI, VII, IX, XIII and XIV; chapter III has also been greatly enlarged to include developments in practically all branches of the subject and is considered to be one of the most important in the book. A new feature of the revised edition is the inclusion of chapter IV on the packing of foods in glass containers as this practice is in vogue in many canneries.

Considering the immense diversity, both in substance and kind, of the foods packed and the fact that the industry of canning is transgressing the rule-of-thumb stage, it is indeed a laudable attempt on the part of the authors to have very ably incorporated in the book pertinent material relating to the more recent factory practices and chemical and biological methods which ultimately aid in controlling the quality of canned foods.

The subject-matter of the second edition is divided into sixteen chapters. The first chapter deals with the statistics relating to production, consumption and import of canned foods as well as the growth of canning industry in the United Kingdom. Essential features of factory location, erection and equipment are then considered in detail with special reference to the canning of peas. That the American practices form the foundation upon which the United Kingdom has based its factory operations is obvious. The chapter on canning is exceptionally useful and deserves special mention. This chapter includes an exhaustive discussion on various essential operations involved in the canning of foods and problems connected therewith, and also information on tin plate manufacture and the industrial process of lacquering. Under the discussion on the packing of foods in glass containers it is interesting to read on p. 86 that serious losses during canning can be avoided by testing the quality of glass containers by means of a mechanical device called "Strain-Viewer". Since all branches of food production are becoming highly specialised industries needing scientific control, hints on the canning laboratory and its work will provide useful guidance to those concerned with the establishment of a reasonably well-equipped canning laboratory. Chemical determinations of definite constituents and impurities in raw foodstuffs, chemical tests to determine the quality of can or glass containers and external and internal examination of canned foods by the application of new analytical methods have been carefully explained. Quality of water for the canned food factory had not, hitherto, received much attention and therefore, a good deal of emphasis has been laid upon the necessity for a chemical and bacteriological examination of water. The inclusion of recent work on microbiology with special reference to thermophilic organisms has rendered the subject-matter thoroughly informatory. The chapter on the effect of canning upon nutritive value is brought up-to-date by the inclusion of recent work on the vitamin value of canned foods. Valuable information has been furnished on the possibilities of converting cannery waste, consisting of fluid effluent, solid refuse and vegetable, meat and fish waste into saleable by-products of medicinal value. The concluding chapter deals with cannery hygiene which is a pre-requisite for controlling the quality of canned foodstuffs.

No serious errors are noticeable in the book but a few minor ones have unfortunately escaped the attention of the editors which, however, do not affect the sound structure of the book. Citation to reference 8 on page 37 is not correct. References 7, 24 and 31; 2; 2, 4, 9 and 44; and 5 and 9 listed in the bibliography on pages 83, 234, 269 and 293 respectively are not indicated in the text. Authors McCartney on page 229 and MacHenry on page 273 are misprinted in the bibliography as McCaitney and McHenry respectively. Serial number 28 of the bibliography on page 83 is repeated. The first one should read 27. Reference to Savage on page 204 should read 2 instead of 1. Reference numbers to Weigert and Stitt on pages 227 and 231 respectively are not correctly indicated in the text and the bibliography. References to Cameron and Yesaie and Clark and Tanner on page 270 should be listed in the bibliography as serial numbers 39 and 40 instead of 40 and 39 respectively. Tables on pages 158–160 and 170–171 are not serially numbered.

A conspicuous omission in the text is the discussion on discolouration in preserved products; the subject of spoilage of canned

foods is not dealt with in sufficient detail. We trust that these subjects will receive adequate treatment in the next edition.

I. A. SAYED.

The Common Commercial Timbers of India and Their Uses. By H. Trotter, I.F.S. (Manager of Publications, Delhi), 1941. Pp. 234. Price Rs. 2 or 3*sh*.

This publication is the second and revised edition of the original book which first appeared some ten years ago. During this interval a considerable amount of research work has been done on Indian timbers and their utilization. Also, a wider section of the public now appreciate that all timbers cannot be equally good for all jobs and that there is such a thing as using the right timber in the right way for any given purpose. The first edition had thus outlived its usefulness. It is the object of this, the second edition, to help the user to make the most of Indian timbers in the light of the latest available technical data. And Mr. Trotter, ably assisted by the experts in charge of the various sections of Utilisation at the Forest Research Institute, Dehra Dun, has produced a book which being concise, technically authoritative but not abstruse, neatly meets the requirements of the lay user of timber who needs *practical* assistance in his daily job.

It is the chief merit of "The Commercial Timbers of India" that it is intensely practical and the author has severely eschewed those aspects of his theme which, however interesting scientifically, controversial or even important, have no practical value in their utilisation. The first four chapters deal with the storage, seasoning, kiln drying and preservation of wood. Chapter V contains a description of common Indian woods. The sixth and the concluding chapter is the prescriptive part of the book and lists "woods recommended for various uses" ranging from aeroplanes to walking sticks—a remarkable list which is at once a tribute to the versatility of wood and to the obvious care and thoroughness with which the book has been written. Two appendices, the first dealing with the comparative strengths of Indian timbers in terms of the values for teak and the second—a very necessary Index of scientific and vernacular names—add to the value of the publication.

While the photographs are not bad, the few diagrams illustrating the text cannot be said to be very clear. Plate II faces the page the wrong way. Mr. Trotter in the preface says that "*Some* Burma species .... have .... been omitted, since Burma is now separated from India". This may be logical but, Burma still continues to supply Indian markets and one cannot help wishing that the author had not made this deletion. The "Trade names" and the "Vernacular names" will not, perhaps commend to universal acceptance because even trade names vary regionally in India; as for vernacular names the actual language in which the name is current is not always indicated (for example on p. 133 for *Michelia champaka*). It is also not very clear on what basis the vernaculars themselves have been chosen for, one occasionally finds the Coorg equivalent of a timber name but not the Mysore or Tamil equivalents. It would be preferable to consistently use (as has not been done on p. 27) italics to denote proprietary brands of preservatives and chemicals for sap stain control. And in Chapter VI on "woods recommended for various uses", one misses the important modern uses of wood—wood flour in the plastics industry, as also the use of wood for bearings. This is presumably due to lack of adequate data which alone would warrant their incorporation in a book primarily meant for the layman.

All these are minor details which do not materially affect the admirable general plan of the book. Here is a volume which is very good investment for a modest Rs. 2 to the timber merchant and the timber user and which should go a very long way in dispelling the not yet extinct fallacy that timber research is the abstruse pastime of well meaning but slightly distorted minds who have no notion of what "the man in the trade" wants.

Radio Frequency Measurements by Bridge and Resonance Methods. By L. Hartshorn. (Chapman & Hall, Ltd., London.) Pp. 282, 99 figures. Price 21*sh*.

This book is the tenth in the series of monographs on electrical engineering published under the editorship of H. P. Young. It is a comprehensive volume dealing with the principles underlying radio-frequency measurements.

The auhor states in the Preface that his aim has been to present, not an encyclopædic account of everything that has been written on the subject, but a systematic

account of the basic principles involved in radio-frequency technique. This aim has been admirably maintained. The book is in three parts. The first part is devoted to a clear exposition of the general principles underlying impedance measurements by the radio-frequency bridge and the precautions to be taken in screening the apparatus. The second part deals with the apparatus used, such as valve generators, detectors and standards of capacitance, resistance and inductance. The last part treats about measurements on ultra short waves by "the stationary wave method".

The book under review has been written by a well-known experimental physicist who has devoted his life-time to the measurement of physical quantities, and is thoroughly conversant with all the practical difficulties in the experimental technique for Radio-frequency measurements. All this valuable experience, is presented in the book for the benefit of the student and the research worker.

A Mathematician's Apology. By G. H. Hardy. (Cambridge University Press), 1940. Pp. 93. Price 3*sh*. 6*d*.

This is a small book of about 100 pages written by one of the foremost mathematicians of England. The book gives stimulating discussions of some points about mathematics which appear very intriguing to a layman. One may not however agree entirely with the author about the necessity of an apology. For *e.g.*, when he says, p. 78, "The mathematics which can be used 'for ordinary purposes' by ordinary men is negligible ...." one can point out that in these times, *e.g.*, electrical appliances are in such ordinary use by ordinary men and the mathematics behind their design is by no means negligible.

K. V.

Symmetric Functions in the Theory of Integral Numbers. By H. Gupta. (Lucknow University Studies No. 14), 1940. Pp. 105.

This is the 14th number of *Lucknow University Studies* being a course of lectures delivered by the author at Lucknow. The book contains an intensive study by the author of some problems in elementary theory of numbers. The first three chapters give a good introduction to the residue classes, primitive roots of a number and forms a good readable matter for the Honours students of our universities. The rest of the book deals with identities which are generalisations of the more elementary theorems such as Fermat's and Wilson's theorems, etc. Some theorems about the properties of Bernoulli's numbers are also dealt with.

The book is warmly recommended to all the college libraries.

K. V.

Common Food Fishes of Shanghai. By Bernard E. Read. Published by the North China Branch of the Royal Asiatic Society, 20 Museum Road, Shanghai, 1939. Pp. 52, figs. 33 (1939).

In the last July issue of *Current Science*, attention was directed to a very valuable publication entitled "Common Marine Food-Fishes of Hong Kong" by G. A. C. Herklots and S. Y. Lin and hope was expressed that the authorities interested in the development of Indian fisheries would bring out similar pamphlets dealing with the important food-fishes of the principal towns of the country. Recently another similar work dealing with the "Common Food Fishes of Shanghai" by Bernard E. Read has reached the reviewer's hands. Though the descriptive part, containing an account of 31 fishes and a cuttle fish, is drawn up on the same plan as in the work of Herklots and Lin, in the other parts more attention is paid to the relative food values of different species by including tables of vitamin contents and of analyses of each of the 65 species into edible part by weight; protein, fat and ash by percentage; and lime, phosphorus and iron by quantities in milligrams. A list of 35 more species is also appended so as to include all the common fish of the Shanghai market. The author has thus embodied in this work a considerable amount of extremely valuable information based on highly technical researches on the protein, fat, mineral salts and vitamin contents of the principal food fishes of Shanghai. The information detailed in this work will be helpful in solving the nutrition problem, especially of the people of the various countries of the Indo-Pacific Region where the same or allied species of fishes occur.

There is one labelling error in an otherwise excellent work to which attention may be invited. In the figure showing the topography of a fish opposite page 5, the author has not correctly indicated the extent of the snout. The snout is the portion of the head in front of the anterior margin of the orbit.

S. L. Hora.

SYNTHETIC MOTOR FUELS*

BY

DR. J. C. GHOSH

(Director, Indian Institute of Science, Bangalore)

THE technique of warfare has been revolutionised in the last decade. Machines decide the fate of battles more than anything else. And they are mostly fitted with internal combustion engines which use petrol in large quantities. A fighter plane of the Hindustan Aircraft Co., develops 1000 H.P. in ten cylinders and consumes more than 200 gallons per hour. Ample supply of petrol is therefore an integral part of a defence programme. In Germany, which has no natural resources in mineral oil, synthesis of petrol has received very considerable attention; and in 1937, she produced 1·4 million tons of motor fuel from her factories as against her consumption of 2·5 million tons. This synthetic fuel was constituted as follows:—Coal tar benzene 300,000 tons, power alcohol 150,000 tons; Fischer-Tropsch oil 150,000 tons and Bergius oil 800,000 tons. Coal tar benzene and power alcohol which are bye-products of other industries cannot obviously be depended upon to yield all the motor fuel requirements of a progressive country. In India, a beginning has been made in the production of benzene from coal tar and of power alcohol from waste molasses; and vast developments in these fields should be possible.

The Bergius process consists in the conversion of coal, tar and creosote into oil by hydrogenation under pressures of 200–700 atm. and temperature of 400–500° C. Use of catalysts like oxides of molybdenum and tin has recently helped to make the operating conditions less severe. The Fischer process, on the other hand, has the merit that the operating conditions are very simple; a mixture of carbon monoxide and hydrogen, in the ratio of 1: 2 is passed over a catalyst at temperatures not exceeding 220° and pressures not exceeding 15 atm. More often a pressure of 1 atm. and a temperature of 185° are employed. In view of this simplicity of operation, the Fischer process is making rapid strides and bids fair to cast into shade the older Bergius process.

The complete Fischer process consists of three parts:—(1) Preparation of synthesis gas ($CO:H_2$ as 1:2), (2) Conversion of synthesis gas into higher hydrocarbons and (3) Processing of these hydrocarbons into motor fuel.

Synthesis gas is now prepared by enriching water-gas ($CO:H_2$ as 1:1) with hydrogen. Considerable economy has been effected in recent years in Germany in the manufacture of water-gas and hydrogen. For example, instead of transporting coke from a coke-oven plant to a water-gas plant where it is converted into water-gas by the action of steam at 1000° C., the German technicians have developed the practice of making water-gas *in situ* by the action of superheated steam on the coke as it is discharged from the coke-oven furnace operating at a temperature of 1200°. Since the ultimate object is to completely gasify the coke into water-gas the very much cheaper brown coal is now used in Germany which yields from the coke-ovens a porous solid fuel capable of much quicker gasification. Hydrogen is manufactured now in a continuous process with the aid of oxygen obtained as a bye-product from the synthetic ammonia industry according to the following simultaneous reactions:—

$$C + O_2 = CO_2 = 98,000 \text{ Cal.};$$
$$C + 2H_2O = CO_2 + 2H_2 - 19,000 \text{ Cal.}$$

If, as in the Lurgi process, the reactions are carried out at a pressure of 10 atm, the carbon dioxide is removed when blowing off the condensed steam, and hydrogen is obtained ready for the enrichment of water-gas. It is claimed that synthesis gas is now produced in Germany at 0·6 Pfg. per m^3.

The catalysts used in the Fischer process consist generally of suitable mixtures of two or more of the carbonates of the following metals:—Cobalt, Copper, Nickel, Iron, Manganese, Thorium. It is expected of the catalyst to selectively disrupt the bond between C and O in carbon monoxide, favour the reaction between this O atom and H_2 to form water, and the reaction between the Carbon with H_2 to form the radical CH_2, which in its turn yields $(CH_2)_n$ or $C_n H_{2n+2}$. The preparation of such a catalyst is even now more of an art than a science; and Fischer's frank statement will be appreciated by all workers in this line:—"After Dr. Tropsch had left me in 1928 in order to found the *Czechoslovakian Institute of Fuel Research* at Prague, it took another six years before Koch, Meyer and I could again produce catalysts of high activity."

The catalysts are kept in vertical cylindrical convertors with arrangements for water cooling, and synthesis gas gives an end product which has the following composition:—

Yield in Grams per m^3 of Synthesis Gas

Paraffin Wax	Oil above 200°	Gasoline Fraction below 200°	Gaseous hydrocarbons more than 50% C_3 and C_4
15	43	73	50

The processing of these Fischer end products to produce gasoline follows the same lines as those developed by petroleum technologists in America. It is the peculiar merit of the Fischer

* A synopsis of a lecture delivered in the Chemistry Colloquium of the Indian Institute of Science on -11-1941.

process that C_3 and C_4 hydrocarbons preponderate in the gaseous products. Their conversion into polymer gasoline by the Ipatief method is quite simple and almost quantitative. These gasolines have very high octane numbers and are prized as aviation petrol. The oil boiling above 200° is processed for Diesel oil, and the residue is subjected to catalytic cracking to yield hydrocarbons which are again converted into polymer gasoline.

Fischer plants in Germany were responsible for production of 150,000 tons of oil in 1937, 600,000 tons in 1938 and 1,000,000 tons in 1939. It is not known what progress has been made during the war. Japan placed orders for 3 Fischer plants from Koppers Co. of Essen in 1938, and their erection was completed in 1939. The question of the cost of production of light motor spirit by the Fischer process was gone into carefully by the Imperial Defence Committee of Great Britain. The estimate came up to 11*d*. per gallon which is not much different from the cost of production of the I.G. Farben-industrie—about 10*d*. per gallon. Before the War of 1914, Germany imported all her requirements of nitre from South America. In 1934, she was producing 1·2 million tons of fixed nitrogen, much of which she was selling abroad at Rs. 350 per ton of fixed nitrogen. It is probable that this war may do for the synthetic motor fuel industry what the last War did for the synthetic nitrogen industry.

The mineral oil resources of India are meagre —small deposits are being worked in Attock and Assam. Following the example of some enlightened European countries, she should insist that mineral oil should be imported in the crude state and refined within her borders. Such refineries in addition to providing employment for skilled labour, will be producing as bye-products, fine chemicals and solvents which are essential for her industrial development. A fuel research organisation with very well-equipped laboratories and financed on a generous scale is one of the crying needs of the hour. We understand that such a project is receiving the attention of the *Board of Scientific and Industrial Research* and we hope that early steps will be taken to bring it into being.

CENTENARIES

Kuhn, Adam (1741-1817)

ADAM KUHN, an American botanist and physician, was born at Germantown, Pa, November 17, 1741. Having studied medicine under his father, he went to Sweden in 1761 to study medicine at the University of Upsala.

There he became a student of Linnaeus. He carried to his professor a new plant of North America in a living state. It belonged to the family compositæ. The professor named it after his pupil and thus Kuhn was immortalised in botanical nomenclature.

From Upsala, Kuhn went to London in 1764 and thence to Edinburgh where he became M.D. in 1767. There his botanical interests were strengthened by his association with John Ellis. Kuhn returned home in 1768 and became professor of botany and materia medica in the College of Philadelphia. He was one of the founders of the College of Physicians of Philadelphia. He was also the first professor of botany in America.

Kuhn died at Philadelphia July 5, 1817.

Foster, Frank Pierce (1841-1911)

FRANK PIERCE FOSTER, an American dermatologist, was born in Concord, November 26, 1841. At the age of 15 he underwent an operation on his right arm and this made him choose his profession. He took the M.D. degree in 1857 from the College of Physicians and Surgeons of New York. He spent a year as a ship's surgeon on a Pacific mail steamer. During his voyages he used his leisure hours in studying German. This scholarship was so kept up by him that he was selected in 1900 to re-edit Adler's *German-English dictionary* (1902).

Having served a while in the army, he settled in New York in 1865. At first he practised general medicine but later specialised in gynæcology. An ingenious method of extracting the fœtus after transverse presentation bears his name.

Still later he specialised in dermatology. Having witnessed the abuses of the then universal practice of arm-to-arm vaccination, he became an earnest propagandist for the use of animal lymph and introduced the manufacture of animal vaccine into America in 1871. He established a vaccine farm which brought him much money. In 1872 he won a prize for his thesis on animal vaccine and in the next year, the British Medical Association invited him to deliver an address on the same subject.

In the seventies he was librarian of the New York Hospital. In 1880, he became editor of the *New York medical journal*. His *Illustrated encyclopœdic medical dictionary* (1888–94), 4V., which was translated into four languages engaged him for twelve years. He was also the editor of the *Reference handbook of practical therapeutics* (1896–97), 2 V. As chairman of the Commission appointed by the American Medical Association to revise the medical nomenclature, he wrote the reports published in 1909, 1910 and 1911.

Foster died of cancer of the throat at Chadwick, August 13, 1911.

S. R. RANGANATHAN

University Library,
Madras.

SCIENCE NOTES AND NEWS

The Effect of Metallic Compounds on Some Grignard-Carbonyl Interactions.—While studying the mechanism of Grignard reactions, Kharasch and others (*J. Amer. Chem. Soc.*, **63**, 2305) have investigated the catalytic effects of several metallic compounds. The benzophenone-isobutyl magnesium bromide interaction which normally yields benzohydrol, is practically unaffected in presence of cuprous chloride; but manganous chloride yields increasing amounts of benzopinacol and less of benzohydrol. Chromic and ferric chlorides are similar in action to manganous chloride but less effective. The yield of trichloroisopropanol and trichloroethanol in the chlorol methylmagnesium bromide interaction is somewhat reduced by cuprous chloride but increased by manganous chloride and metallic manganese. This interaction is inhibited to a large extent by ferric chloride. Further investigations in this interesting field will no doubt throw more light on the control of Grignard reactions.

M. R. A.

Splenectomy and Immunity of Rats to *Nippostrongylus*.—Except for an enlargement of the spleen in cases of infections like Trichinosis, Scistosomiasis and Ancylostomiasis, no attempt has been made to determine the influence of the spleen in relation to natural and acquired resistance to metazoan parasitic infections, and Yutuc's study (*Phil. J. Sci.*, 1941, **75**) on the effect of splenectomy on the natural and acquired resistance of rats to *Nippostrongylus muris* is therefore the first work where a correlation between the two is attempted. Curiously the results show that splenectomy does not reduce the natural resistance of rats to *Nippostrongylus* infection. In fact, resistance appears to increase as a result of splenectomy as shown by the lower egg output, smaller worm burden and delay in the death of the rats. The production of immunity therefore is not influenced by the removal of the spleen where the operation was done before immunisation. Very slight reduction in immunity was noticed when splenectomy was performed after immunisation.

Plasticisers for Shellac.—The effects of various plasticisers on the different properties of the shellac film is described in Technical Paper No. 20 of the London Shellac Research Bureau, maintained by the Indian Lac Cess Committee.

In the present investigation, the London Shellac Research Bureau have examined about 30 plasticisers for the prevention of crazing, resistance to water and solvents, rate of drying, scratch hardness, flexibility and other properties. It has been found that no allround plasticiser can be recommended for shellac. However, when any one property is particularly desired in the resulting film, a plasticiser can generally be recommended for the purpose. Thus for ensuring water resistance, plasticisers like sextol phthalate, cyclohexanol tartrate and para-toluene sulphonamide may be used. When resistance of the film to the action of hydrocarbons is desired, the last two among a few others tested may be employed. In the same way, other plasticisers can be selected when resistance to scratch or a high degree of flexibility is the main consideration.

This investigation has brought to light several facts on the general behaviour of plasticisers towards shellac from a theoretical point of view. For instance, those plasticisers which were incompatible with shellac (like, for example, castor oil) were least effective. Mixtures of low-boiling solvents, when used for preparing the varnish, behaved better than when used singly, presumably due to the interlocking of these molecules and producing a different effect in the ultimate film. It was also found that, as may be expected, plasticisers containing hydrophilic groups were less effective from the point of view of the water-resistance of the film. In the case of the monester plasticisers, which are most often employed nowadays, the aromatic phthalates were superior to aliphatic phthalates in increasing the water-resistance of the film.

To an unusual degree, the production of **photographic lenses involves** the integration of physics, chemistry, mechanics and mathematics, and the difficulties are scarcely realised by the average purchaser of a photographic objective. In the first place, lenses are required for many specific purposes and a lens computed for one purpose rarely suffices for another. The designer has four variables with which he works: the properties of the glass, the curves of the surfaces, the thickness of the lenses and the spaces between them. He is confronted with a series of conflicting conditions, and the final result must necessarily be a compromise since all the aberrations cannot be fully corrected. The modern photographic objective is indeed composed of a number of elements rarely less than four and frequently eight, depending on its type. A lucid and fully illustrated account of the various aspects of making photographic objectives is given by E. W. Melson (*Bausch & Lomb Optical Company*) in "Photo Technique" of July 1941.

Industrial Research in Hyderabad.—For the promotion of industrial research in the State

a new organisation—the Scientific and Industrial Research Board,—has been recently inaugurated. An initial Government grant of Rs. 25,000 is announced for undertaking research on problems having immediate and direct bearing on the development of industries in the Dominion. The Board will carry on its work through eight research Committees. The number of such committees will be increased, if and when the need arises and their services will be available for private industrialists who may refer their problems to them for expert opinion.

National Institute of Sciences of India.—At a meeting of the Council of the National Institute of Sciences of India, held on Thursday, the 6th November 1941, in the rooms of the Royal Asiatic Society of Bengal, Calcutta, the following gentlemen were declared to have been elected Fellows of the Institute:—

Ordinary Fellows.—Dr. J. K. Basu, M.SC., Ph.D. (Padegaon). Dr. Ram Behari, M.A., Ph.D. (Delhi). Dr. H. J. Bhabha, F.R.S. (Bangalore). Dr. N. L. Bor, M.A., D.SC., F.L.S. (Dehra Dun). Dr. B. B. Dikshit, M.B.B.S., Ph.D., M.R.C.P., D.P.H. (Bombay). Dr. P. K. Ghosh, M.SC., D.I.C., D.SC. (Calcutta). Prof. G. S. Ghurye, M.A., Ph.D. (Bombay). Prof. B. C. Guha, D.SC. (Calcutta). Dr. R. C. Majumdar, Dr.Phil.Nat. (Calcutta). Dr. S. C. Mitra, M.A., D.Phil. (Calcutta). Dr. S. R. Savur, M.A., L.T., Ph.D. (Bombay). Prof. R. C. Shah, M.SC., Ph.D. (Bombay). Prof. B. N. Singh, M.SC., D.SC. (Benares). Mr. V. P. Sondhi, M.B.E., M.SC., F.G.S. (Calcutta).

Honorary Fellows.—Dr. E. B. Bailey, F.R.S., Director-General, Geological Survey of Great Britain. Prof. E. S. Goodrich, M.A., D.SC., F.R.S., Linacre Professor of Zoology and Comparative Anatomy, Oxford University. Major M. Greenwood, D.SC., F.R.C.P., F.R.S., Professor of Epidemiology and Vital Statistics, London School of Hygiene and Tropical Medicine. Prof. E. O. Lawrence, Radiation Laboratory, California University, Berkeley, U.S.A.

University of the Punjab.—The appointment of **Dr. A. N. Puri** as Professor of Physical Chemistry in the University of the Punjab has been announced. Dr. Puri has had a brilliant academic career and has more than 100 papers on Soil Science to his credit. Soil Scientists are familiar with various types of apparatus devised by him, such as Puri Siltometer and Puri Chaino Hydrometer for the mechanical analysis of sands and soils respectively. He is well known for his work on the mechanical analysis of soils and studies in soil colloids and base exchange.

Dr. Bashir Ahmed has been appointed Professor of Organic Chemistry in the University of the Punjab. After undergoing post-graduate training, first in the University Chemical Laboratories, Lahore, and later in the University College, London, he was appointed Assistant Professor of Biochemistry and Nutrition in the All-India Institute of Hygiene and Public Health, Calcutta.

In 1937, Dr. Ahmed was awarded a Fellowship of the Rockefeller Foundation, New York. During this fellowship he spent one session at the Johns Hopkins University with Professor E. V. McCollum and six months at the University of Cambridge, Great Britain. The fellowship afforded him an opportunity for extensive travel in America and Europe, during which he visited renowned centres of chemical research in no less than 66 different universities and organisations.

Dr. Ahmed has published some fifty research papers in different fields of chemistry and biochemistry. His main field of research has been the subject of Vitamins to which he has made valuable contributions.

MAGNETIC NOTES

The month of September 1941 was on the whole less active than the preceding month. There was one day of *very great* disturbance, 5 days of *moderate* disturbance, 18 of *small* disturbance and 6 *quiet* days as against 2 days of moderate disturbance, 19 of small disturbance and 9 quiet days during the same period of 1940.

The day of largest disturbance was the 18th when a severe magnetic storm was recorded. The quietest day during the month was the 6th. The day-to-day classifications of characters is shown in the table below:

Quiet days	Disturbed days		
	Slight	Moderate	Very great
3 to 6, 27, 30	1, 2, 8 to 12, 15 to 17, 21 to 26, 28 & 29	7, 13, 14, 19 & 20	18

There were 3 storms, two of moderate intensity and one of very great intensity during the month as against a moderate storm recorded during September of last year. A detailed description of the storm of very great intensity which occurred on the 18th September 1941, has already appeared.[1] The monthly mean character figure for September 1941, is 1·00 as against 0·77 for September 1940.

October 1941 was on the whole much less active than the previous month. There were 16 *quiet* days, 12 days of *slight* disturbance and 3 of *moderate* disturbance as against 10 quiet days, 19 days of slight disturbance and 2 of moderate disturbance during October 1940.

The most disturbed day during October 1941, was the 31st while the day of least disturbance was the 3rd. Classification of individual days was as shown in the following table:

[1] *Curr. Sci.*, 1941, **10**, 432.

Quiet days	Disturbed days	
	Slight	Moderate
1-7, 13, 17-19, 25, 27-30	8-10, 12, 14-16, 20, 21 23, 24, 26	11, 22, 31

Three moderate disturbances were recorded during October 1941 as compared with one moderate storm during October of last year.

The mean character figure for the month was 0·58 as against 0·74 for October 1940.

M. R. RANGASWAMI.

ASTRONOMICAL NOTES

The Sun will be at the winter solstice on December 22.

Planets during December 1941.—Mercury is a morning star until December 22 when it reaches superior conjunction with the Sun; it will be rather too close to the Sun to be seen this month. Venus continues to be a superbly brilliant object in the western sky soon after sunset. It is getting rapidly brighter and will be at its greatest brilliancy on December 29, its magnitude at the time being —4·4. It should be possible to see the planet even in full daylight. Mars, although fading in brightness, will still be a fairly prominent object with a reddish colour (magnitude —0·5) very near the meridian in the early part of the night.

Jupiter which will be in opposition to the Sun on December 9, can be seen nearly all night during the month. Its magnitude when brightest will be —2·4, *i.e.*, more than twice as bright as Sirius, the brightest star in the heavens. Saturn will, likewise be a fairly bright object in the eastern sky in the early part of the night. Both Saturn and Uranus are near each other and move slowly in a retrograde direction in the constellation Taurus.

The well-known meteoric showers named the Geminids are due to appear in the second week of December. The dates of maximum display are December 11–12 and the position of the radiant point is given by R.A. 110° Declination 33° North very near the interesting double star Castor (α-Geminorum). The meteors of this group have generally swift short paths and their colour is white.

T. P. B.

SEISMOLOGICAL NOTES

During the month of October, 1941, ten slight and one moderate earthquake shocks were recorded by the Colaba seismographs as against one great, six moderate and two slight ones recorded during the same month in 1940. Details for October, 1941, are given in the following table:—

Date	Intensity of the shock	Time of origin I. S. T.		Epicentral distance from Bombay	Co-ordinates of the epicentre (tentative)	Depth of focus	Remarks
October 1941		H.	M.	(Miles)		(Miles)	
3	Slight	19	48	2620			
5	Slight	12	35	4930			
8	Slight	10	54	4400			
8	Slight	20	54	2100			
9	Slight	00	41	1930			
13	Slight	03	20	1270			
24	Slight	02	34	1490			Epicentre probably located near the Andamans
27	Slight	21	08	3280			
29	Slight	06	28	2130			Epicentre probably located near Sumatra
29	Slight	13	13	760	Probable epic.: Lat. 26°·6 N., Long. 63°·5 E., in Baluchistan		
31	Moderate	12	01	1760	Epic.: Lat. 25° N., Long. 100° E., in Yunnan Province, China		

ANNOUNCEMENTS

The Twelfth Conference of the **Indian Mathematical Society** will be held at Aligarh, under the auspices of the Muslim University, on 27, 28 and 29 of December 1941.

The Reception Committee at Aligarh has been constituted as follows: Dr. Sir Zia-ud-din Ahmad, M.A. (Cantab.), M.L.A., Vice-Chancellor, Muslim University, Aligarh (*President*); Prof. A. M. Kureishy, M.A., Head of the Mathematics Department and Provost (*Vice-President*); S. M. Kerawala, Esq., M.A. (Cantab.) (*Secretary*); Abdulla Butt, Esq., M.A., B. A. Siddiqi, Esq., M.A. (*Joint Secretaries*); O. R. Sherwani, Esq., M.A., Treasurer, Muslim University (*Treasurer*).

As the University is making arrangements for the boarding and lodging of visitors, all those who intend to attend the session are requested to write early to the local Secretary about the date and time of their arrival and whether they are vegetarians or non-vegetarians. It is hoped that all lovers of mathematics will attend the session and contribute to its success.

All-India Medical Conference.—The eighteenth session of the All-India Medical Conference will be held at Hyderabad (Deccan), on the 26th, 27th and 28th December 1941, under the kind patronage of H. E. H. the Nizam's Government. Dr. B. C. Roy, Dr. S. R. Moolgaonkar, and Dr. N. A. Purandare will preside over the deliberations of the Medical, Surgical and the Obstetrical Sections respectively.

An Industrial and Scientific Exhibition has been arragned.

The University authorities have kindly placed the University buildings at the disposal of the Conference. Intending visitors may communicate with Mr. Brijmohanlal, Osmania Medical College, Hyderabad, for further details regarding the Conference.

Indian Academy of Sciences.—The Seventh Annual Session of the Indian Academy of Sciences will be held at Nagpur on 24th, 25th and 26th of December 1941, under the auspices of the Nagpur University. There will be a Symposium on the Industrial Development of the Central Provinces and Berar, two popular lectures and meetings for the reading and discussion of scientific papers.

Essays in Anthropology.—Arrangements have been completed for the publication of the volume to be presented to Rai Bahadur Sarat Chandra Roy, M.A., B.L., F.N.I.

A limited number of copies are being printed on account of the high prices of materials.

The price of the volume has been kept at Rs. 12 and orders for copies should be sent early to Dr. D. N. Majumdar, Anthropological Laboratory, University of Lucknow, Lucknow.

The volume comprises contributions from:—

Mr. J. P. Mills, Dr. B. S. Guha, Dr. A. Aiyappan, Prof. K. P. Chattopadhya, Rev. Dr. Verrier Ellwin, Dr. D. G. Mandelbaum, Mr. P. G. Shah, Prof. Baron Von Furer-Haimendorfer, Mr. G. H. Archer, Mr. P. Kodanda Rao, Dr. E. W. Macfarlane, Mr. N. K. Bose, Rev. Stephen Fuche, Prof. A. Aiyar, Mr. W. V. Grison, Mr. David Roy, Prof. N. N. Sen Gupta, Prof. Radha Kumud Mukerjee, Prof. Radha Kamal Mukerjee, Rev. W. J. Culshaw, Dr. D. N. Majumdar and others.

It is regretted that on page 439 of Vol. 10, No. 10, Fig. 3 in the note entitled "Chromosome Number in *Sesamum prostratum* Retz.", by Dr. S. Ramanujam, was printed incorrectly with 16 and 14 chromosomes in the two anaphasic groups. The correct reproduction of the figure with 16 and 16 distribution is given below:—

3

We acknowledge with thanks, the receipt of the following:—

"Journal of the Royal Society of Arts," Vol. 89, Nos. 4592–94.

"Journal of Agricultural Research," Vol. 63, No. 1.

"Agricultural Gazette of New South Wales," Vol. 52, Part 9.

"Biological Reviews," Vol. 16, No. 3.

"Journal of Chemical Physics," Vol. 9, No. 9.

"Chemical Products," Vol. 4, Nos. 9–10.

"Experiment Station Record," Vol. 85, No. 2.

"Indian Forester," Vol. 67, No. 11.

"Transactions of the Faraday Society," Vol. 37, Part 8.

"Indian Farming," Vol. 2, No. 10.

"Review of Applied Mycology," Vol. 20, Parts 7 and 8.

"The Mathematics Student," Vol. 9, No. 2.

"Scripta Mathematica," Vol. 8, No. 1.

"The Indian Medical Gazette," Vol. 76, No. 10.

"Journal of Nutrition," Vol. 22, No. 3.

"American Museum of Natural History" (Journal), Vol. 48, No. 2.

"The Philippine Journal of Science," Vol. 75, No. 3.

Nature," Vol. 148, Nos. 3743–44, 3746–47.

"Indian Journal of Physics," Vol. 15, Part 4.

"Journal of Research," (National Bureau of Standards), Vol. 27, No. 2.

"Canadian Journal of Research," Vol. 19, No. 7.

"Science and Culture," Vol. 7, No. 5.

"Indian Journal of Veterinary Science and Animal Husbandry," Vol. 11, Part 3.

"Indian Trade Journal," Vol. 143, Nos. 1842–46.

BOOKS

"Text-book of Physical Chemistry," by Samuel Glasstone. (Macmillan & Co., London), 1940, pp. xiii + 1289.

"A Text-book of Electricity and Magnetism," by G. R. Noakes (Macmillan & Co., London), 1941, pp. x + 513. Price 8/6.

"A First Course in Algebraic Geometry," by B. B. Bagi, Dharwar, 1941, pp. vi + 264. Price Rs. 2-12-0.

"The Common Commercial Timbers of India and Their Uses," by H. Trotter. (Manager of Publications, Delhi), 1941, pp. iv + 234. Price Rs. 2 or 3/-.

ACADEMIES AND SOCIETIES

Indian Academy of Sciences: (*Proceedings*)

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